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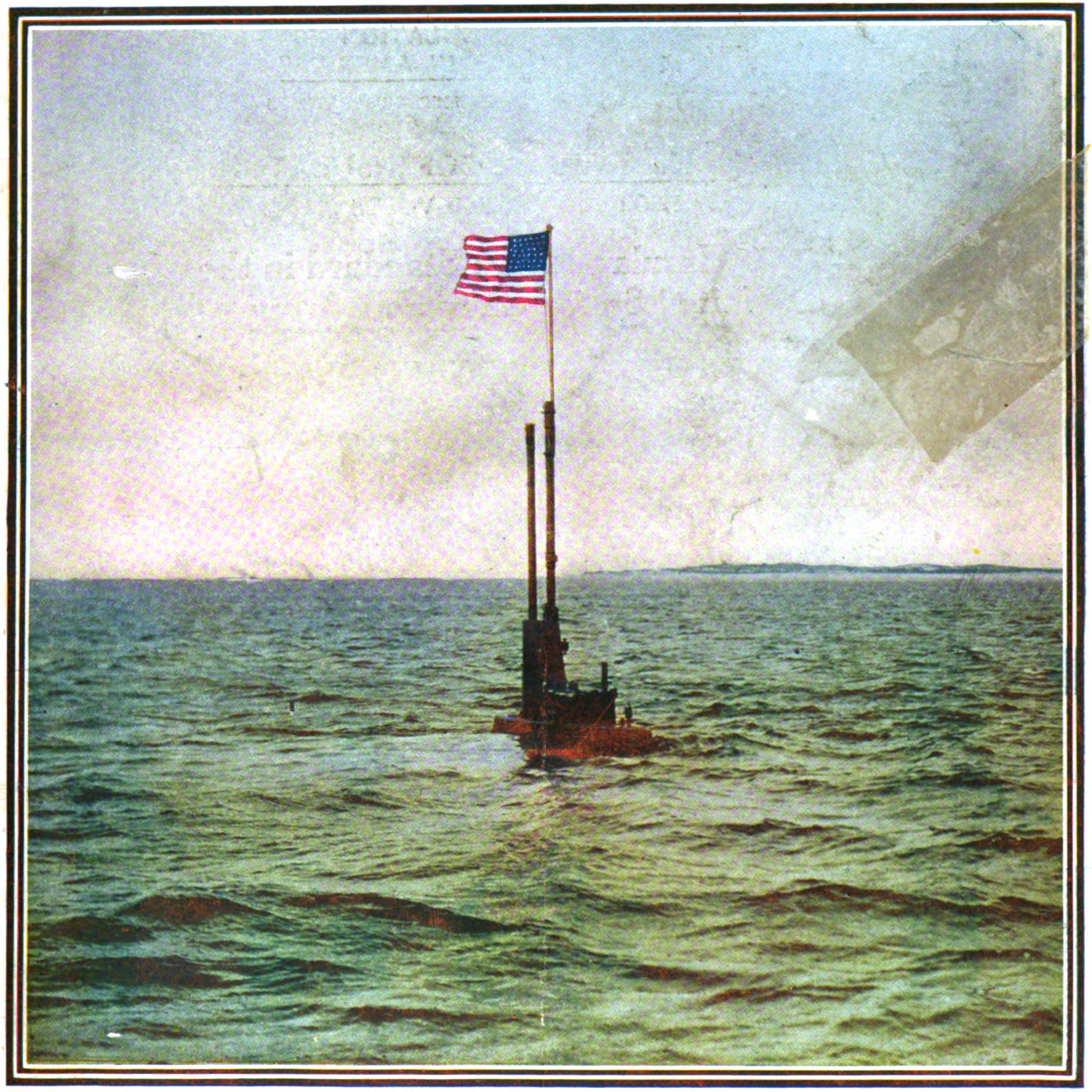

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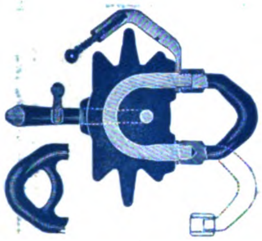
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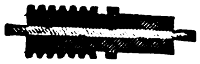
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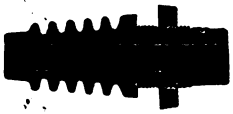
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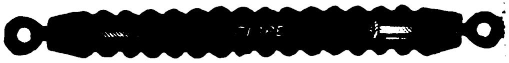
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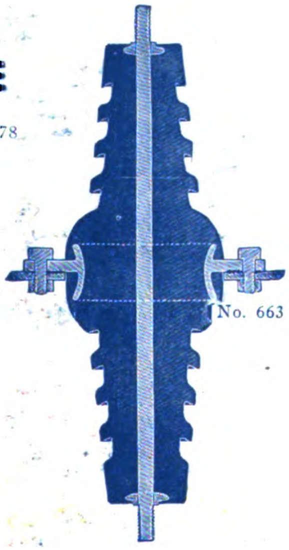
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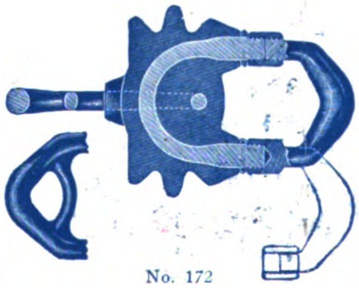
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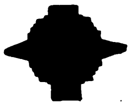
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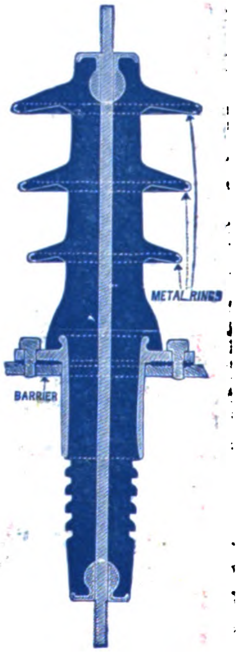

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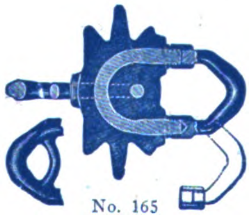
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The prospective radio man should bear in mind that the Marconi Institute has more than 4,000 graduates to its credit. The majority are now serving in either the Army or the Navy. Thousands of men are still required by our Government.

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The radio laboratory of the Institute is more completely equipped than other training organizations of its kind in the United States.

Students are not only taught the theories of the art but they are given the opportunity to manipulate and adjust the most modern types of apparatus in use in the year 1918. Moreover. they receive the benefit of the years of practical experience of the staff of instructors—men who have been identified with the commercial, scientific research and administrative branches of radio communication since its inception.

Students may attend day or evening classes throughout the year. The New York school alone has facilities for teaching 550 students a day.

The Institute is open daily for inspection and you are cordially invited to visit the school any day from 10 A. M. to 4 P. M., and 7.30 P. M. to 9.45 P. M., except Saturday, on which day the school closes at noon.

Prospective students are always welcome for personal interviews.

A very interesting and instructive, fully illustrated, 96-page manual has been prepared showing the possibilities and opportunities in the radio field and the facilities for training young men at the Marconi Institute. A copy will be gladly forwarded to you upon request.

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The Wireless Age

Edited by J. ANDREW WHITE

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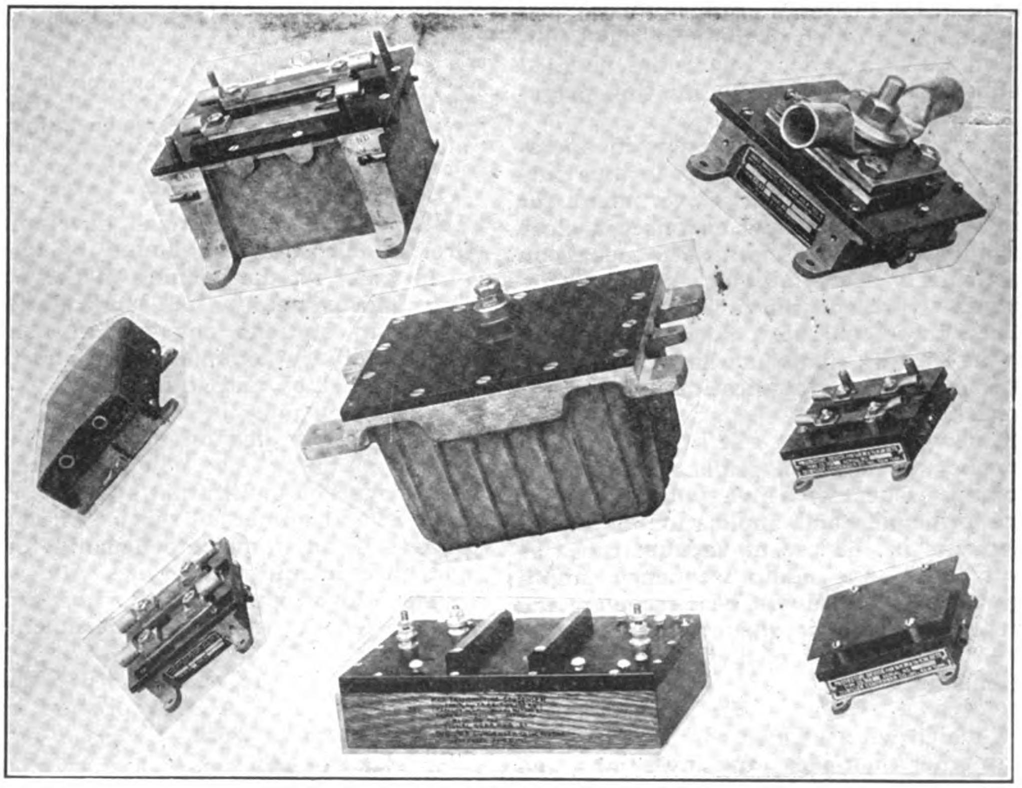

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To Our Readers

THE new appearance of The Wireless Age, in the large size and lighter weight, is a step taken in co-operation with the War Industries Board to aid in the conservation of paper. It is also a step in advance, the first step for a broader editorial policy and a better magazine for our readers. The opportunities to display illustrations to better advantage is but one of the many merits of the new size; typographical arrangement and more equable division of features will also recommend it to readers. Then there is the editorial policy.

Since our country entered the war wireless work has been concentrated on war interests; since the beginning, and, in fact, even before the declaration of war, we have made the Age of direct practical value to readers who have gone into the service and those looking forward to a call to the colors. The progressive study courses in arts of war have been carefully followed by thousands of men with deep interest, and with appreciation, too, as shown by their letters. Entire Signal Corps battalions, from the Major down to the privates, including all men in the unit, have subscribed in bulk in order to get the detailed instructions given exclusively by this magazine.

Another draft of fighting men is in operation. The magazine's usefulness is thus further increased. While our Government for most excellent reasons now exercises a close censorship over the art, both as to operation and particularly as to military and naval developments at present, the time is not far distant when there will be a flood of most intensely interesting data marking marvelous advances in, and new applications of, the art of wireless.

Much new information, not in conflict with public policy, is ready for publication and our forthcoming issues will give you an insight into the principles and application of recent developments in the use of vacuum tubes as detectors, radio and audio frequency amplifiers, regenerative receivers, beat receivers and generators of radio frequency currents, together with applications of these tubes in wireless telephony.

The Wireless Age is the only medium through which wireless men can communicate to one another their ideas and inventions, and find out what is going on in the art during this extraordinary period.

HIGH-POWER STATIONS for trans-oceanic work, about which the layman knows little or nothing, will continue a live subject, handled, as in the past, by the engineers in charge of the Marconi system. The value of these exclusive articles is instanced by the detailed observations which have already been given of the power circuits, the control of currents from 300 k.w. alternators, the special antennae circuits for sending and receiving, amplified and made clear by data compiled in operation on both Atlantic and Pacific Coasts.

RADIO SCIENCE—This department is the most widely quoted source of wireless information among technical magazines. In it all developments of importance are recorded, both in mechanical advances made in design of apparatus and discoveries which establish new principles. The careful selection of subjects and the world-wide aspect of the research make this a distinctive and tremendously valuable feature. Representative of the best thought abroad and in the United States, it opens up new avenues for personal and patriotic experimental research, and will keep Age readers in advance of the recorded progress of the art.

PAN-AMERICAN STATIONS—The new commercial era dawning in Pan-America is demanding a wireless service spanning vast distances and for continuous operation. Extensive plans now being executed will be covered in exclusive articles containing descriptions and illustrations of the new wireless circuits and the opportunities the new services will create in the radio field.

EXPERIMENTERS' WORLD—By reporting in a broad way the latest advances in electrical and mechanical apparatus, this feature supplies an inspirational source for all electrical workers. Special attention is given to the contributions of readers, affording excellent opportunities for them to secure public recognition of meritorious work and for the exchange of ideas with all those of an inventive turn of mind. The remuneration for such contributions may readily become a source of income for carrying on further experimenting.

OPPORTUNITIES IN THE RADIO FIELD—Great commercial development in wireless telegraphy is bound to follow the world war. At the opening of the war there were approximately 700 land stations and 4,500 ship stations engaged in commercial service, military communication and the service of lightships and lighthouses.

Vast extensions have since taken place. Wireless is installed on thousands of vessels and all continents are now connected into a world-wide communication system which will be open for commercial service after the war.

There is an immediate demand for skilled radio men in military service, who will have a wide field of opportunity in future commercial and federal and local government service after the war.

You can use the opportunity presented in THE WIRELESS AGE to prepare for useful and remunerative work.

Government restrictions on newsstand distribution, to conserve paper supplies, make it desirable that each reader now subscribe for one year, sending subscriptions through their local newsdealer, or direct to us if more convenient.

THE PUBLISHER

Vol. 6. No. 1. October, 1918

THE WIRELESS AGE

WORLD WIDE WIRELESS

Wireless Telegraph and 'Phone for Lighthouses

GREAT BRITAIN is establishing on her coast radio lighthouses, equipped with combination wireless and phonographic instruments. These lighthouses are particularly valuable in thick weather, when the light is frequently invisible. The name of the lighthouse is repeated automatically by wireless every five seconds, the intensity of the sounds being so regulated that ships equipped with an ordinary wireless receiving apparatus will hear the signal the same approximate distance that the light could be seen in clear weather.

Skilled Radio Operators Needed in Tank Corps

SPECIAL opportunity to enlist in the tank corps, the only branch of service now open, is to be given drafted men between 21 and 31.

Men in deferred classification will be accepted, but none in Class 1 will be taken unless especially trained as a radio wireless operator or acetylene welder.

No person wearing glasses will be taken, and the minimum height and weight is 5 feet 6 inches and 130 pounds.

Blacksmiths, cooks, stenographers and wireless operators are especially desired.

Indications of the Growth of the Wireless Industry

IT IS well known to those engaged in the wireless art that few outsiders have any appreciation of the size of the industry. While many published accounts of increased use of radio appear in the newspapers and periodicals from time to time, the haze of romance which envelopes wireless seems to prevent these items from registering on the public consciousness. It is safe to say, for example, that the average business man would be greatly surprised to know that one branch of the military establishment purchased in a two weeks' period ending July 25th, the following wireless equipment: 9,500 complete wireless sets, 6,365 motor-generators, 20,000 sets of head 'phones, 10,000 antennae systems, 125,000 insulators, and great quantities of electrical supplies such as wave-meters, potentiometers and rheostats.

Considering the many branches of the army organization and that these purchases were for but a single branch, some idea may be gained of the quantities of equipment being made for the navy and merchant marine.

It is significant, too, that the report of the committee on education and special training announced at the same time that of 47,243 soldiers in the United States being given vocational training for service overseas, 6,693 were in the electrical class, engaged largely in radio operation.

Wireless Versus Long-Distance Cables

AT THE annual meeting of the English Marconi Company, Managing Director Godfrey Isaacs made the following statement:

"We have many important negotiations in many parts of the world of which it would not be wise of me to speak today, but I think one may fairly contemplate that the business of wireless telegraphy will be no less important when peace comes than it has been during the war. In speaking with a very eminent officer of the United States Navy Department a day or so ago, he told me that, although before the war he was of a very different opinion, he has now come to the conclusion that no new long-distance cables will ever again be laid; that, in his view, wireless telegraphy is thoroughly efficient for all telegraphic purposes. It would not be, perhaps, altogether advisable for me to express such views, but I think you will be glad to hear those of a practical man holding such an important position in so great and progressive a country as the United States.

Sykes in Philadelphia Evening Public Ledger. Copyright, 1918, by the Public Ledger Co.

"Lightning trained Yankees iss right"

German Clandestine Radio Apparently Silenced

GOVERNMENT agents now feel sure they have stopped all means of clandestine cable or radio communication between the United States and Germany.

After investigation they have found it takes usually four or five weeks for information published in this country to be published in Germany or Austria.

This is about the time required to carry newspapers or mail matter to Germany through the north European neutral countries. Repeated tests, officials say, have shown that important news reached the German government only through American newspapers, copies of which were actually carried to Germany or the adjoining neutral countries.

The Kaiser: Can't we make some of that American "Pep?"
Chemist: Not in an imperial laboratory, your majesty

Army's New Radio Schools Supplant French

TRAINING schools for radio work have been established by the division of military aeronautics at West Point, Ky., and Camp McClellan, Ala., field artillery firing centers, and instruction work along these lines will eventually be extended to Fort Sill, Okla., and Camp Jackson, S. C., and also to field artillery firing centers where observation schools of the division of military aeronautics are now working in co-operation with the artillery branch of the service.

These are only a few of the first steps in co-ordination that are now being instituted by the different branches of the service in the camps of this country. Heretofore advance schooling was to be obtained only when the American troops reached France.

Instruction in radio covers wireless communications between the fliers in the air and the gun crews on the ground below. By means of radio the fliers are able to signal for barrages, the location of batteries, ammunition dumps, infantry, trains, and other targets and also to "spot" for its own particular battery, which means to tell that battery whether its shells are landing to the right or left, over or under the target fired at.

Norway-American Wireless Link Forged

THE Farmand, a Norwegian trade journal, has the following article concerning the Stavanger wireless telegraph station: "The great wireless station erected near Stavanger by the Norwegian government for telegraphic connection with the United States has recently been completed. Trial messages have been exchanged between the station and the Belmar wireless station, near New York, and had the very best telegraphic results. The Stavanger wireless is one of the most powerful stations in the world and, as far as equipment is concerned, no doubt the one most up to date. The Norwegian-American direct telegraphic connection will afford considerable advantages to men of business on both sides of the ocean. Thus the wireless service will, according to the contract between the Norwegian Telegraph Department and the American Marconi Company, highly reduce the rates for telegrams between the two countries, and it will likewise save time for the business world, the station being of the duplex type and able to work in both directions simultaneously and at a higher telegraphic speed than attainable in the Atlantic cable service."

Torpedo Freak or Wireless Control?

WAS the Sommerstad sunk by a dirigible torpedo? The question was raised by the fact that after missing the steamer the deadly weapon swung about and this time struck. Capt. Hansen expressed no opinion, thinking that the swerve may have been due either to wireless control or to defective mechanism. Naval experts at Washington are said to ridicule the suggestion of wireless control, and explained that the mechanism can be so set that the torpedo will come back like a boomerang to the hand of the thrower. Thus set, they are quoted as saying, a torpedo becomes almost doubly effective, because if it fails to hit the mark it has a second chance.

Some of the reports, however, are not consistent with this theory, for they describe the torpedo as appearing to port, passing under the ship, circling with a radius of less than 100 feet, and striking the steamer on the port side where it was first seen. This might point either to a vagary of the mechanism or to wireless control, which occurs to everybody because so many inventors have been working for it, and with some measure of success. But if the Germans possess a really effective device of this sort, it will soon be made manifest; the cases which suggested dirigibility have been just frequent enough to make it probable that a new case is but one more freak of an automatic torpedo.

Antenna Springs for Minimizing Shock

ACCORDING to The Electrician of London, there has recently been patented an invention which reduces to a minimum the risk of wireless aerials on vessels being broken and the wireless apparatus thus put out of action when a ship becomes mined or torpedoed.

The invention is stated to be simple and inexpensive, and utilizes one or more long extension springs specially constructed and fitted at each end of the present aerials, these springs automatically extending and contracting to allow the aerial to lengthen or shorten to take up the varying distances between the top of the masts when they spring out of position through an explosion. These springs do away with the present necessity of lowering the aerial when a ship is being loaded, as they allow for the vibration of the masts caused by working the derricks, and their use would in some cases save the aerial being blown away by shell fire.

Secret Station Near Cartridge Works Discovered

A POWERFUL wireless outfit was seized at Bridgeport, Conn., on September 5th by army intelligence officers, following a two week vigil from the shelter of a cornfield. The plant was discovered on the upper floor of a house and had a sending radius of 150 miles.

A youth describing himself as Charles Mudry, 18, a wireless student, was arrested during the raid. He declared he received instructions from an older man. The plant, which is located next door to that of the Union Metallic Cartridge Co.'s factory, has been in operation over six months.

British Seaplanes Use Wireless Extensively

WHAT could be more natural than that the airman who forces the hidden power of the atmospheric air to maintain his craft aloft, should employ that same ether to carry his message to earth. There are other methods of communication, of course, but wireless telegraphy is predominant.

The wireless branch is a very highly specialized department, says Lieut. W. A. Robson of the Royal Air Force. Its work is of first importance.

At sea wireless is extensively used in connection with submarine chasing. Seaplanes, flying boats and airships carry out long patrols in co-operation with destroyers. Immediately the aircraft sight a U-boat the destroyers are informed by wireless of its exact location. This method is highly successful, for a submerged submarine which is invisible from sea level can be seen clearly from the air in good weather. It is a significant fact that every German submarine is fitted with an anti-aircraft gun.

Every pilot in the British air service must pass certain tests in wireless telegraphy before he is allowed to graduate; and in consequence at practically every home training station the air is made musical by the sound of many practice "buzzers."

Disabled Soldiers Taught Radio in Atlanta

THE most advanced work in the new science of "reconstructing" disabled soldiers is under way at Fort McPherson General Hospital 6, Atlanta, Ga.

Thirty different courses of instruction are given now to help cure sick men, to put them back into active service, or to begin their training for some vocation in civil life.

This hospital, created since we went to war, has an exceptional advantage in the re-education of disabled soldiers because the Fort McPherson reservation contains the great industrial shops of the quartermaster corps, which repair all kinds of army equipment.

More than 500 patients have taken curative courses of some kind—60 of them taking only light bedside or ward work; the rest going into classes that range all the way from newspaper reporting to farming.

Under the commandant of the hospital, Col. T. S. Bratton, the work is being carried on by Chief Educational Officer John L. Riley. He has 20 assistants, and many convalescents have trained to act as instructors.

Motor mechanics, telegraphy, radio, typewriting, mechanical drafting, sheet metal work, plumbing, stove repairing, steam fitting, blacksmithing, electric wiring and clerical work are some of the courses that are being given.

In many cases the men go back into certain branches of army work. A man who has lost a foot or a leg is just as valuable as a telegrapher as a whole man.

In other cases, he has laid the foundation for a trade through which he can earn his living in civil life.

Nauen Wireless Range Now 6,000 Miles

THE German wireless station at Nauen has been greatly improved since the outbreak of the war, says the Frankfurter Zeitung. Instead of a single transmission tower 300 feet high, it now has ten towers ranging in height from 890 feet to 360 feet, while the distance through which messages can be transmitted has been extended to 6,200 miles. The German paper is quoted as saying that the Nauen station's services have proved invaluable for instructing cruisers and U-boats and that both the Goeben and Breslau received through Nauen instructions to steam into the Bosphorus.

Tuthill in St Louis Star

Another Garabad motor

A New Japanese Long-Distance Station

THE installation of a new high power wireless system between Japan and the United States is actively engaging the Japanese department of communications. Officials announce that the project is a result in part of the very great congestion and delay in cable transmission which prevents the desired freedom of communication between Japan and the United States.

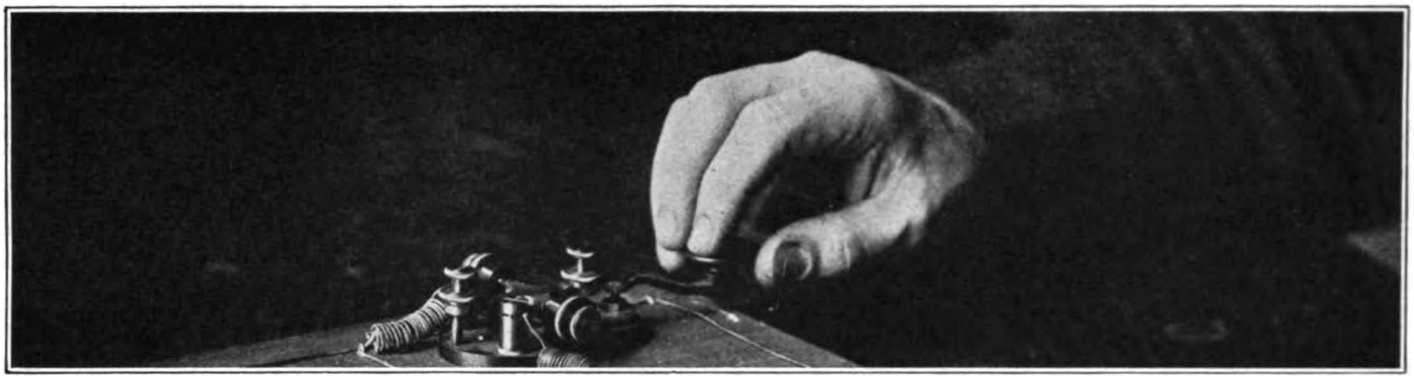
The present Japanese high power station communicated direct with the Marconi station in Hawaii. The proposed station will work with a station on the Pacific coast, the site of which probably will be near San Francisco, a distance of 4,600 miles. This will be one of the longest direct wireless services in the world. The estimated cost of a new wireless system is about $400,000.

While another cable linking the two hemispheres is desired, a line from Japan to Guam alone would cost $3,000,000. It is expected that details of the new wireless project will be announced shortly.

Compulsory Wireless Ordered By Greece

THE Greek Government has required wireless equipment on all passenger vessels of 300 or more tons dead weight capacity and on all cargo vessels of 1,000 or more tons.

(*Continued on page* 36)



The correct position for telegraphing, a matter of greatest importance to beginners

How Code Sending Is Taught

By Gordon Lathrop

Of the Marconi Institute

AMONG the batch of applicants for enrollment in the New York school of the Marconi Institute, on a Monday morning several months ago, were two young men who shall be named, for the purpose of this article, Dunbar and Baxter.

They came to the enrollment desk together. They aspired to become army aviators; each had just turned eighteen years of age. They lived within a few doors of each other in a Long Island suburb of the metropolis, had been classmates in the same prep school and were of the same social status—of clean, unaffected, all-American stock. The war-time spirit of each was equally high; the plans of their parents had been to send them to one of the great universities, but the boys had elected instead to enter the service of their country. In the Marconi Institute they expected to become proficient in the radio requirements demanded of all military aviators.

Their first day at the school found them memorizing the code in dots and dashes. They were told that each succession of dot or dash, or combination of dot and dash, produced a distinctive cadence which they must learn to recognize. They listened to the reproduction of Instructor Chadwick's sending contained in Victor-Marconi record No. 1. They learned the proper "grip" for sending. In the respects noted in the foregoing paragraphs the boys had points of contact in common. But here the resemblance ended.

Telegraphically, as indicated in their "form" in sending, these two students illustrated the extremes of faulty production of the signals. Land line telegraphers have the phrases "in the mud" and "in the air" to designate these two extremes. When sending comes to a receiving operator with scarcely recognizable distinction of dot and dash, with loose construction of components, in a heavy, "sticky" style, he says it is "in the mud." When it is too light, with "split" dots and unrhythmic relationship, one to the other, of the components, the sending is said to be "in the air."

"Pull it up," the receiver will demand when the sending is "in the mud." "Let it down" he will direct if the trouble is of the opposite nature.

Often the source of the trouble is in poor adjustment of the apparatus. A correct balance is then a matter of technical knowledge and skill. If, however, there is nothing wrong with the balance of the apparatus, the responsibility of making the correction rests with the sender. The writer, using Dunbar and Baxter as examples, hopes to indicate the way to achieve the happy mean which lies between the two erronenous extremes.

Because with both boys the trouble was largely temperamental, a description of each is necessary. Dunbar was shorter than Baxter, but heavier. He was sturdily set up; an ideal build for guard or center of a football eleven. Baxter was built like a sprinter, with slim waist and long legs. Nervous energy seemed to radiate from him. Dunbar, mentally as well as physically, was of less speed but greater endurance than Baxter. Dunbar's tendency was to think first, carefully and in detail, and act afterwards. Baxter, on most occasions, acted first and thought afterwards; fortunately his instincts guided the majority of his acts in the right direction. Dunbar's heavier features and slower manner of speech in contrast to Baxter's flashing animation suggested to an observer lessened dynamic force. But on better acquaintance Dunbar convincingly showed a potentiality fully as great as his more brilliant friend. Their service-rendering capacity—if that phrase may be used to measure intrinsic worth—was equal, but one was expressed in brilliant, forceful spurts, the other in steady, even-tempered plodding.

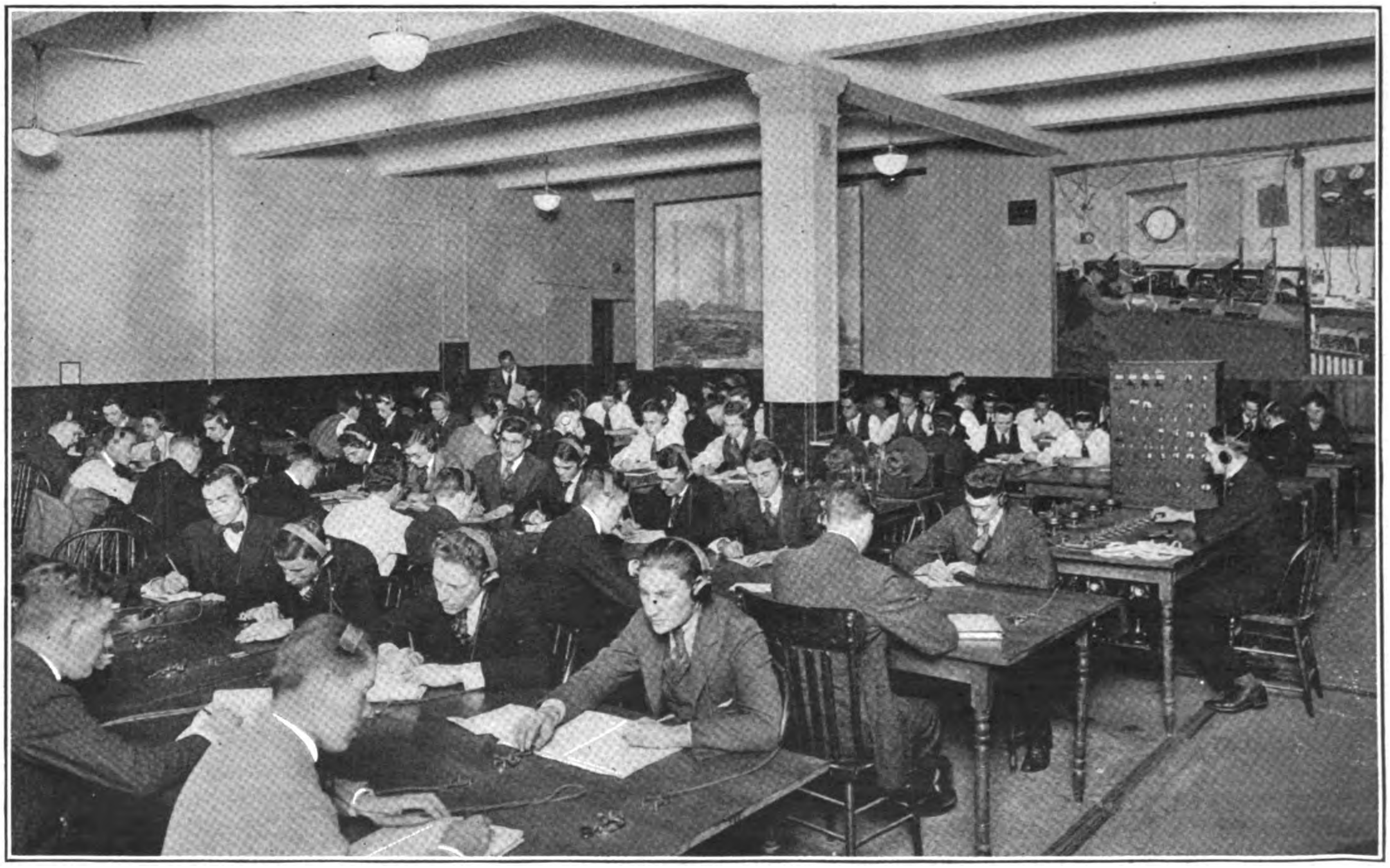
In precisely the ways indicated by the terms "in the mud" and "in the air" each boy began to produce the cadences of the dot and dash combinations in the beginners' room of the Institute. No doubt it would be absurd to state that an analysis of the sending style of a telegraphic aspirant will serve as an infallible guide to that aspirant's personality. In the cases of the two young men who are used here as illustrations, however, their strikingly opposite personalities were so accurately reflected in their opposite methods of faulty production of the code that the sketches of their personalities are worthy of note.

Dunbar's temperament, influencing his production of the code, caused him to cling to the idea that he had to visualize each letter in dots and dashes before he began to send it. He did this persistently, notwithstanding the instructor's efforts to induce him to conceive each signal rather as a cadence—of the letter "A," for example, as a staccato note and a legato note, occurring in quick succession, rather than to consider it as "dot" plus "dash." His mind's tendency toward inertia lost him the facility to adapt himself quickly to varying circumstances or unaccustomed processes of thought. The mind appeared to wrestle with his hand, wrist and arm; he produced the dots and dashes coarsely, heavily, "in the mud." He "let down" in the tension of the members which have to do with sending, or, better expressed, he failed to "pull up" with them sufficiently, so that he was continually without the proper "spring" of wrist and hand to make the immediate recovery of hand after each downward pressure. Physically, the focus point of trouble was in his wrist, the physical source of the trouble with nearly all poor senders. He couldn't seem to strike the correct degree of action at the wrist. His first impulse was to try to construct the signals with completely relaxed hand, with wrist barely clearing the table. That threw the responsibility of making the downward pressures upon his fingers. He concaved his index finger and second finger and tried it that way with negative results. Then he would swing to the other extreme, stiffen his wrist and raise the under part three inches above the table. That is more than twice too high a position for the wrist, as it bows the arm at that point and necessitates a full arm motion. With his wrist at that position, Dunbar's production of the dots and dashes was with a ponderous, punching motion of the arm from the elbow, as impossible a method as that of the fingers alone. His sending was "in the mud," heavy, loose in construction, without individuality of each separate dot and dash and each separate signal.

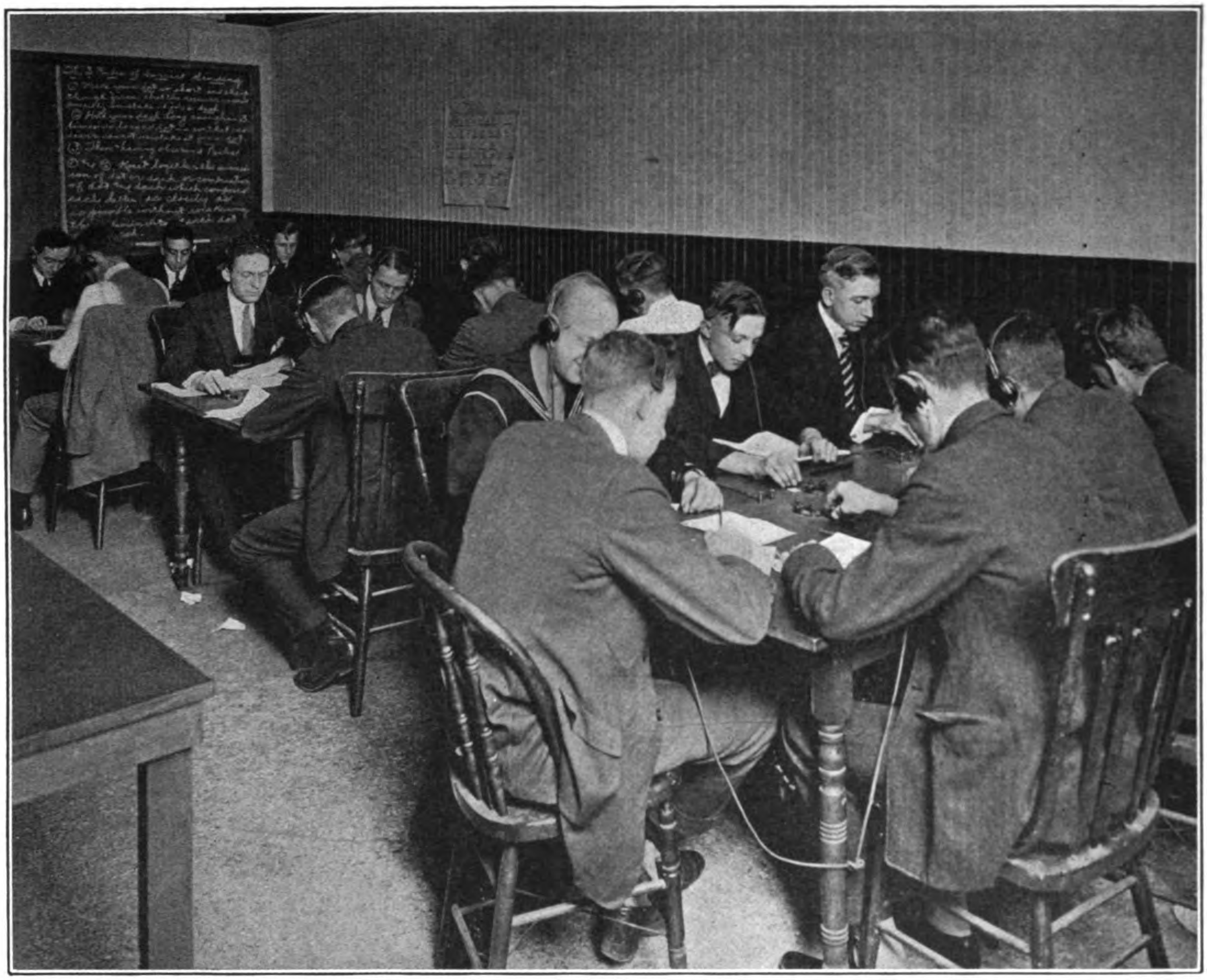
Baxter had been keenly interested in his friend's struggles at the key. His quick mind had grasped at once the significance of conceiving each signal as a sound, to be dealt with in its entirety. His error was that he wanted to begin immediately at the fourth stage of the development of a sender, before he had mastered the first, second and third stages. He wanted to take up the morning newspaper and send page one before luncheon. The details which produce the proficiency to do that meant little to him. His temperamental impatience manifested itself immediately in his sending. Not having achieved that fine balance of hand, wrist and arm which comes from long apprenticeship at the key—which is necessary before one can send with speed and style, and endure—he called upon his abundance of nervous energy. He was not content to learn to make each downward pressure, whether a dot or a dash, with a distinct action of his wrist. He could not do this speedily enough. So he stiffened his wrist and hand, and drew on the nerves of hand and arm to make the dots. As is always the case in "nerve sending," most of the dots he made lacked substance. They were "split." His sending came jerkily, erratically. He would make a "V," for instance, with a speed of construction that would entail a pace of twenty-five words a minute to be in proper relationship to the other letters. Then he would make an "O," immediately following, perhaps, at a ten-word a minute pace. A plotted line of the progress of his sending would look like the trail of one of those loud-buzzing insects which dart this way and that, covering fifty feet to progress a straight line distance of ten feet. His style was up in the air; too tense, too highly geared, too light in substance and erratic in progress.

Physically, as with Dunbar, the focus point of trouble was at his wrist. There was nothing wrong with the position of thumb, index finger and second finger on the key knob. His hand made the proper, graceful curve on the key. His index finger was properly convexed when he began to send, and his second finger lay easily in place over the edge of the key knob. Third finger and little finger were curved without tension, clear of the key, to give his hand the proper balance. He proved to be a proficient telegrapher later, while the progress of Dunbar was slow and painful. The latter, in his mental make-up, was considerably more of the analytical type, without marked keenness of perceptions. Baxter's perceptions, on the other hand, were so keen that he was under continual temptation to exercise them to the neglect of his reasoning faculties. Telegraphically speaking, Dunbar was a trifle "in the mud," while Baxter was "in the air."

To correct the telegraphic errors of each, the instructors gave them "follow copy" practice, to register the sound of each letter in their minds, sending was arranged for half-hour periods at a time, then they were made to listen over and over to the Victrola reproduction of Mr. Chadwick's sending. That, with repeated corrections of the tendency of each to use a finger motion, instead of an up and down motion at the wrist, was all



This view of the northwest corner of the main code room of the Marconi Institute shows the students arranged at progressive tables according to the radio telegraphing speed they have acquired. The equipment provides for 250 students daily, all of whom are preparing for military service. Seated at the master table, right center, is the author, exponent of the physical and psychological study of pupils to determine the best method of correcting telegraphic errors



A corner of the beginners' room of the Marconi Institute, where men training for military service are made proficient telegraphers by the individual instruction plan. The practice sets are arranged in pairs, and as soon as the students acquire fundamentals, those with opposite faults take the paired keys and head telephones and spend hours sending to each other. In this way the faults of one are made plain to the other, and by discussion and practice each acquires flawless sending.

they could do. The burden of correction lay with the boys themselves through the experience gained from day to day.

* * *

In the beginners' room of the Marconi Institute the practice sets are arranged in pairs, a pair of keys and a pair of head telephones on a separate circuit. Until both boys had achieved a speed in receiving of six words a minute, they spent most of the hours of code practice sending to each other. There they worked out their telegraphic problem, in the same manner, no doubt, in which they have worked out other problems, of both less and greater importance than learning the code. One boy's faulty extreme was checked by the other, and a degree of balance was attained. Dunbar gradually "pulled up," while Baxter "let down." From the aviation ground school has come the report that Baxter's work at the front will probably be in a combat plane, while Dunbar's greater capacity for detail work has indicated that he will do better in a plane giving directions to the artillery.

Leaving the two young men at this point in the care of their instructors at the ground school, the writer will note what, in his opinion, are the necessary four stages of development to produce a first class sending telegrapher.

The first is when learning to construct each letter, numeral and punctuation mark in accordance with what he terms Rules 1, 2 and 3. They are:

"Make your dot so sharp and short, though firm, that the receiver cannot possibly mistake for a dash; make your dash long enough—three times as long as a dot—so that the receiver cannot possibly mistake it for a dot; knit together the components of each succession of dot or dash, or combination of dot and dash as closely as possible without weakening the individuality of each dot or dash."

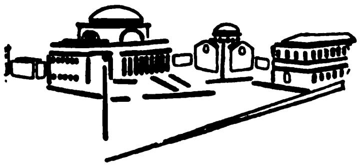
The second stage is when the sender is learning to make a succession of letters to compose a dictionary word, code word or a cipher combination in rhythmic steadiness.

The third is when he is building up strength and power enough of hand and wrist to endure the sustained strain of sending which practical telegraphy calls for.

The fourth is when he puts the final touches to his sending which produce style and speed.

That the word "speed" occurs but once in the outline of these four stages, and then as the last word, should be held significant, as the chief cause of the great number of mediocre and poor hand senders in both land line and radiotelegraphy is that "speed" becomes of too great importance in the telegrapher's mind before he has earned the right to use it.

Progress In Radio Science



Langmuir's Method of Constructing Gas-Free Electrodes for the Vacuum Tubes

IN order to obtain the exceedingly high vacuum so essential in connection with the operation of the vacuum tubes, it is necessary that the metallic elements inserted in the envelop be gas-free. Various methods have been described by which a cathode in a vacuum tube could be disintegrated so as to form a coating of metal on the inside of a glass bulb to act as one of the metallic elements, but in these processes there must necessarily be present a gas at a pressure of about 1 micron. Under these conditions the metal film is strongly adherent, and since a certain amount of gas appears to be fixed on the metal, it will consequently be given up, and prevent the emission of pure electrons from the filament.

Dr. Langmuir has recently shown a method whereby the anode of the vacuum tube consists of a coating of metal sprayed on the inside of the bulb by incandescing a refractory metallic conductor such as tungsten in a partial vacuum. To accomplish this the temperature must be sufficiently high to actively vaporize the refractory metal. This vaporized metal is deposited on the walls of the vacuum bulb as a hard strongly adherent film, which even when so thin as to be transparent, is a good electrical conductor, and capable of carrying relatively heavy currents. In fact Langmuir has described a three-electrode vacuum tube, in which an anode made in the foregoing manner was capable of receiving plate currents of 100 milliamperes or more.

In the tube shown in figure 1, one of the filaments can be employed as the cathode of a two-electrode vacuum tube, and the other to supply the vaporized metal for coating the interior of the tube. The device then becomes a two-electrode valve, and can be employed as an oscillation detector or as an ordinary rectifier.

The tube shown in figure 2 is essentially a three-electrode vacuum tube. Dr. Langmuir mentions that it is not necessary to supply an extra filament to be vaporized, but that the main filament 2 can be made large enough that part of its metal can be deposited on the inside of the bulb to act as the anode; in other words, the grid and filament of the vacuum tube are inserted during the original construction, but the metallic coating for the anode or plate is deposited by bringing the temperature of the filament up to a high degree of incandescence.

The process of manufacture is as follows:

Referring to figure 1, the envelop 1, consisting of glass, quartz or similar non-conducting material, is provided with two vaporizable conductors 2, 3, consisting of tungsten, tantalum, or molybdenum and provided, respectively, with leading-in conductors 4, 5 sealed into a stem 6 in the usual manner. One of these filaments 2, 3 may be used for the cathode of the completed apparatus and the other may be vaporized by heating it to incandescence by passage of current. The particles of vaporized metal travel outward in all directions in straight lines. In order to avoid the formation of a continuous conducting film over the entire inner surface of the container and in electrical contact with the cathode, provision should be made for intercepting the vaporized metal near the cathode so as to "cast shadows" on the envelop wall which will be free from deposited metal. This may be done by shaping the stem 6 so that it will in part bulge outwardly, also by providing knobs or rings on the leading-in wires as shown at 7, figure 1, or 8, figure 2.

The container is first exhausted to a good vacuum as may be obtained by means of a pump by chemical exhaust or other means, the envelop being heated during pumping to remove water vapor. The preliminary exhaust should reduce the pressure to one micron (0.001 m.m.) or less. The completion of the vacuum may be carried out by the active vaporization of a tungsten conductor in a side chamber by heating it electrically to about 2700° to 2900° C., preferably in the presence of a small amount of anhydrous pentoxide of phosphorus. The envelop is then sealed off, as indicated at 9, and one of the refractory conductors, for example, the filament 3 is heated to about 2700° to 2900° C. by passage of current, thereby depositing the desired gas-free film as indicated at 10. Contact is made to the film 10 of vaporized metal by sealed-in wires 11, two being provided to insure a good contact. This film is gas-free and so hard and coherent that even when no more than 10^{-6} m.m. in thickness it can only with the greatest difficulty be scratched off the glass with a knife.

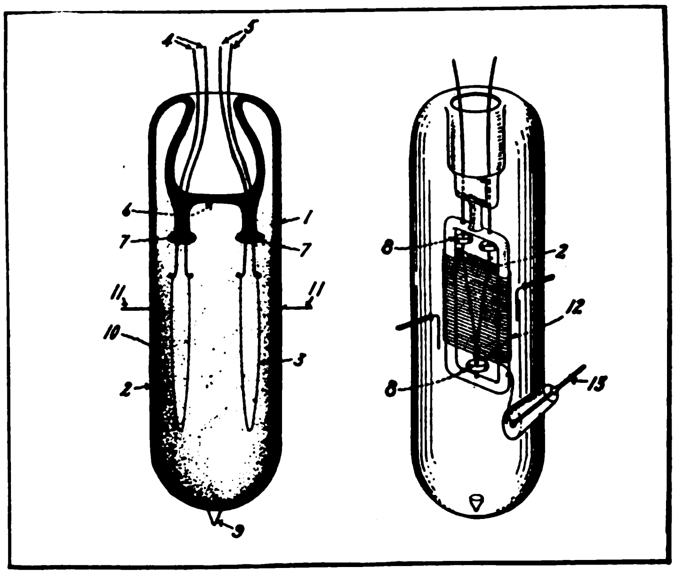


Figure 1 (left)—Tube which can be employed as an oscillation detector or as an ordinary rectifier

Figure 2 (right)—Three-electrode vacuum tube constructed by Langmuir's method

This device may be used as a relay by providing a discharge controlling grid 12, figure 2, connected to a leading-in conductor 13. In the device shown in figure 2 no separate conductor for producing the anode film has been provided, as the cathode 2 may itself serve to provide the vaporized metal without serious damage when an extra heavy filament has been provided to serve as cathode.

Langmuir's Method for Preparing the Three Electrode Vacuum Tube

MUCH time and thought have been expended by various investigators in the preparation of the three-electrode vacuum tube to insure that previous and during the process of exhaustion the tube will be free of all air or occluded gases. Dr. Langmuir has previously shown in the Proceedings of the Institute of Radio Engineers, the construction of the three-electrode tube known as the pliotron, which he has been successful in developing. A recent modification of the construction of this tube is shown in figures 1 to 4 inclusive, figure 5 showing the use of the new tube in a particular circuit. Figure 1 illustrates an electron discharge tube completely assembled. Figures 2 to 4 inclusive show alternative forms of electrode grid construction in accordance with recent researches, figure 2 showing the construction of the cathode.

The cathode consists of a substantially straight filament 4 of highly refractory material, preferably tungsten, and provided with terminals 5 and 5′. The filament is attached to a light spring 6 between two oppositely disposed supports 7 and 8 constituting a frame-work, which is made of insulating material, such as glass or quartz. A number of turns of wire 9 are wound closely in such a way as to be out of contact with the hot cathode. This element constitutes the usual grid, which by means of an external potential exerts a static control upon the electron discharge of the tube. The anode is strung in a zig-zag manner over hooks 12 upon fork-shaped supports 13 and 14. The anode and the grid are preferably made of tungsten, but other gas-free metals may be employed.

One advantage of constructing the anode in this manner is that inasmuch as it makes a continuous conductor, it can be conveniently heated by the passage of a current during the evacuation of the tube, suitable terminals being supplied at 15, 15′.

It is not necessary for all purposes to provide connections for each end of the grid as shown, but it is desirable to do so when the potential applied to the grid is small and in the case of a straight or linear cathode the potential gradient along the grid may be made the same as that on the filament. In some cases this is of great advantage.

The connections of the new tube for use as an amplifier are shown in figure 5, in which a battery 18 supplies the heating current for the filament 4, and a battery 19 of the same voltage as battery 18, is applied to the terminals of the grid element 9, so as to produce a potential gradient along the grid the same as that along the filament. The current or potential which is to be amplified may be applied to the coil 20 which is connected between the grid and filament of the tube. A battery 21 may also be connected in this circuit to impress upon the grid a potential at which the device will amplify to its best advantage.

It is obvious that with this arrangement the difference of potential between any point on the cathode and the portion of the grid nearest thereto, will be the same along the entire length of the cathode. As usual a battery 22 connected between the plate and filament furnishes current for the operation of a telephone receiver 23.

In preparing the apparatus, the preliminary exhaust is carried out by methods such as used in incandescent lamp manufacture. The anodes are then subjected to an electron discharge or bombardment by impressing a suitable voltage between the cathode and anode. When the anode consists of a conductor such as wire 11, figure 1, it is preferably heated by passage of current either before or during the bombardment. If desired the grid 4 may also be heated during the evacuation of the device. When the anode is plate shaped heating may form part of the treatment by electron bombardment, the discharge current being made heavy enough to heat the anode. The voltage should be so chosen at the beginning of the electron discharge treatment that blue glow is absent in the tube. This indicates the ionization of the residual gas by collision of gas molecules with electrons is taking place and under these conditions disintegration of the cathode is apt to take place. The discharge voltage is progressively increased, the gas being removed as fast as evolved, preferably by a Gaede molecular pump. This treatment is ordinarily continued until the discharge voltage is higher than the voltage at which the device is normally operated, but this rule will not hold true when the operating voltage is very high as substantially all the gas may be removed before the operating voltage is exceeded. Evacuation of the device should preferably be carried to a pressure as low as a few hundredths of a micron or even lower, although no definite limits may be assigned. In any event, the evacuation should be so low that no appreciable gas ionization takes place during normal operation. When the cathode and anode are very close together and the discharge is confined to a direct path, a greater gas pressure is permissible than when the opposite is true.

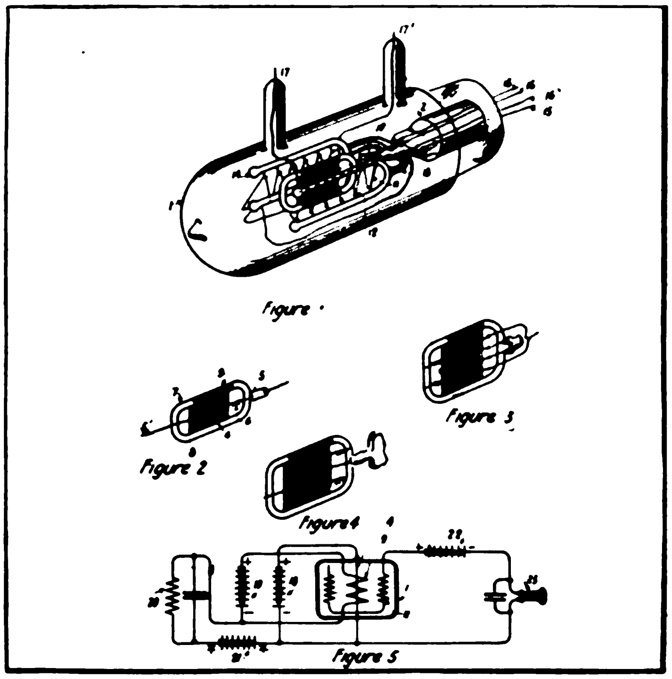


Figure 1—Electron discharge tube. Figure 2—Cathode. Figures 3 and 4—Two types of electrode grid construction. Figure 5—Use of tube in a circuit

An electron discharge tube may be used in receiving systems for radio telegraphy. The passage of electron current across the evacuated space between cathode and anode is controlled by the static potentials impressed upon the grid. A tube prepared as described may be used to transmit currents limited in potential only by the dielectric strength of the glass, quartz or other material of the tube and the mechanical strength of parts subjected to static forces.

A Vapor Arc Generator for the Production of Radio Frequency Currents

BENJAMIN LIEBOWITZ has recently shown a novel apparatus for the production of oscillations of constant amplitude through the use of enclosed vapor discharge tubes. Two methods for use of this apparatus are shown in figures 1 and 2. In one form the apparatus consists of a vapor electric arc device having two cathodes

(*Continued on page 39*)

Torpedoed!

By Alfred S. Cresse

WHAT does the ominous word of the title mean to you? Press accounts usually tell of ships being sunk by giving brief data, such as the time, place and tonnage, leaving the fuller details to the imagination of the public.

Running through the U-boat blockade to allied ports has been an almost continuous job for me since the beginning of the war and I have met with varied experiences which have left within me no tender feeling for the Boche.

To give a clearer idea of what submarine sinkings mean I will tell of my experiences on board a torpedoed ship.

I was assigned as chief Marconi operator to the steamer Owasco. This vessel was formerly the Allemannia of the Hamburg-American Line, taken over by the United States Shipping Board, and loaded with a cargo of high explosives and gasoline for Genoa, Italy. We sailed from New York on November 17th for Norfolk, Va., to take on bunker coal for the voyage. We left Norfolk on the 23rd and had a rather uneventful voyage, arriving at Gibraltar thirteen days later. But Fate had yet to play her hand.

Two days after our arrival we left for Genoa with a convoy of three other merchant vessels with orders to run close to the coast of Spain. The first day everything ran clear; then, a few minutes before midnight, I heard a muffled explosion. I was on watch copying war warnings from a French station, so I quickly switched off the lights—a necessary precaution to be taken when opening a door or port while in the war zone—and looked outside. All was quiet. I returned to my work and called my assistant, Operator Decker, telling him what I had heard and advising him to dress quickly.

I had no sooner readjusted my receiver when a distress signal came in. I never received the name of the ship, for an instant later there was a deafening crash beneath us. The whole ship shook and trembled from stem to stern, and seemed to shudder at the death blow. Fixtures and fittings were torn from their bases and thrown to the decks. The wireless cabin was shifted several feet off its base.

A deafening explosion followed. The torpedo had entered the hatch forward of the bridge where the gasoline was stowed. Instantly the gas fumes exploded with great violence, blowing the hatch covering several feet in the air. A few seconds later flames were roaring out of the opening with a sound like one would expect from a gigantic blow torch.

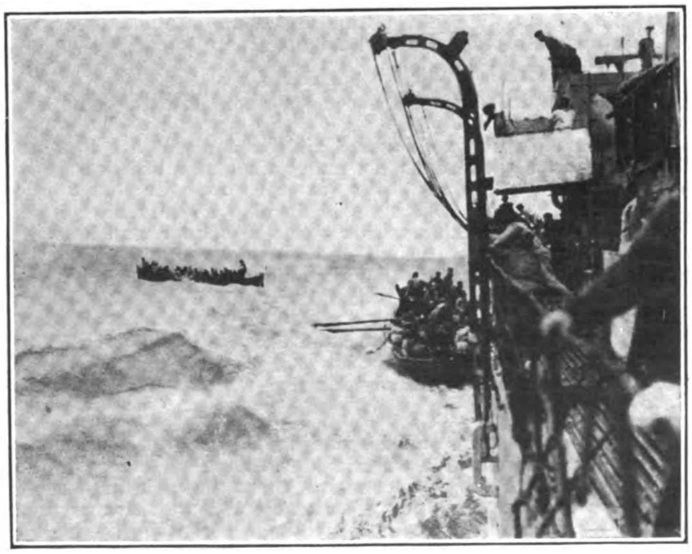
The wireless transmitting apparatus was disabled by the explosion. I got this in what I considered temporary working condition, only to find that the current was cut off from the mains, when the wireless cabin was torn from its place.

During the period when I was attempting to make repairs I had given little thought to the perilous situation. It was my job to get the set in working condition and flash out an S O S—that alone occupied my mind. Now, the roar of the conflagration penetrated my consciousness.

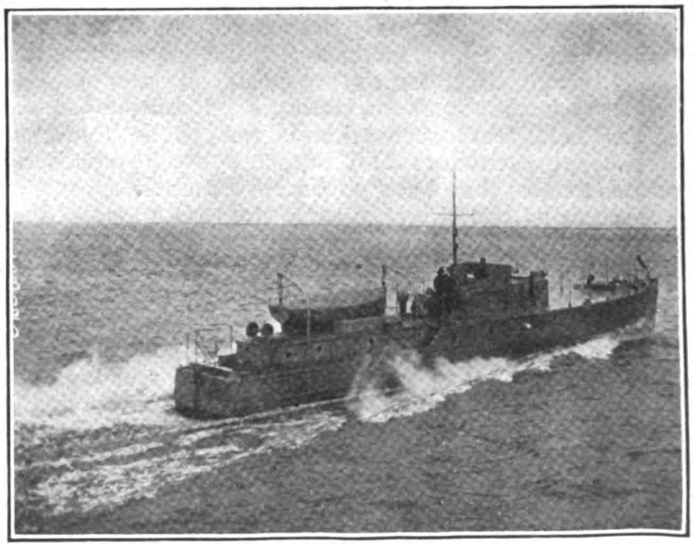
I decided to find the captain and consult him as to my next move. Upon going out on deck I found conditions much worse than I had expected. The canvas around the bridge was in flames and the ropes were blazing. The lifeboats had already been lowered. Apparently Decker and myself were the only ones left aboard.

We rushed to the starboard side and looked over. Number one boat was already lowered. I called to the captain, asking him if there was room for us; he answered that there was. Decker went first; leaping from the deck to the boat he fell a distance of about eight feet, then slid down into the boat. I followed in the same manner. We then pulled away from the side and lay off a safe distance. The ship was sinking fast on an even keel. Fourteen minutes after being struck the tops of her masts sank beneath the waves. All that remained

(Continued on page 18)



Operator Cresse's ship caught fire when torpedoed; the crew took to the boats before he arrived on deck



Returning home, on January 13th, a French submarine patrol was picked up off Bermuda. Twenty Frenchmen on board were near starvation

How To Become An Aviator

The Fifteenth Article of a Series for Wireless Men in the Service of the United States Government Giving the Elements of Airplane Design, Power, Equipment and Military Tactics

By J. Andrew White
and Henry Woodhouse

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Instruction In Flying—First Flights

THE theory of aviation may now be said to be fully covered and the student ready for text on actual flight. If the preceding installments have been carefully studied there is no evolution of the airplane which is not entirely understandable to the reader. The function and operation of the airplane as a whole, and its controlling means as separate and unified parts, will be clear without further explanation in the description of the various flight maneuvers. One point may well be repeated here, however, to fix the matter clearly in the student's mind. That is the results of operation of the stick control and rudder, which may be simplified as follows:

To go down, push the stick control forward.
To rise, pull it back.
To tilt to the left, push it left.
To tilt to the right push it right.
To turn left, rudder with left foot.
To turn right, rudder with right foot.

Thus it is seen that the movements are the natural ones; for example, if the airplane is tilted sideways to the right the natural tendency is to lean left. Pulling the stick to the left rights the plane; and so on, each motion being the automatic one, so to speak.

During early stages of flight training the pupil must not hesitate to tell the instructor if at any time he feels physically or temperamentally unfit. Flying when not mentally inclined for the instruction will quickly ruin an aviator's prospects for later success, and any hesitancy about stating his condition for fear of a "cold feet" accusation is not to be tolerated. Aviation instructors and students are sympathetic, earnest men; they have no time for taunts.

Acquiring confidence in early stages is a tremendous help; until it is acquired the first solo flight should not be attempted; usually, after five hours dual-control instruction, the elementary machine may be flown solo. Some fifteen or twenty flight hours on various elementary types is generally sufficient, and the faster airplanes may then be used. Take-offs and landings should be frequent in practice, for nothing more quickly instills confidence than knowledge that the matter of alighting has been mastered.

TURNING

Turning with the novice almost invariably reveals one fault, i. e., the banking is too steep. This must be corrected before the aviator attempts the steep turns. The following general rules will prove useful in learning to turn the airplane correctly.

A good altitude margin should be allowed, so there will be at least 500 feet to correct for bumps or side-slips.

First turns should be very wide and not through more than 180 degrees, or half-turn.

While turning, speed should be kept up to at least level flying speed, and the airplane nosed down to its normal gliding angle. If flying speed is lost, the machine will side-slip or stall, getting into the cabré, or tail down, position which is dangerous to the novice.

As the natural tendency is to lose height, it is best to turn the airplane against the wind at first.

Aileron and rudder controls should be handled gently and first turns made gradual ones.

Figures 93 and 94 show turns improperly made. A turn too flat causes an outward side-slip, and too steep banking an inward side-slip. Either of these faults are perceptible to the aviator by the feel of the wind on his face. During a right turn, for instance, a noticeable wind on the opposite, or left, cheek indicates an outward side-slip. This is corrected by gently pushing the stick to the right for more bank or turning the foot bar for less rudder. When the opposite effect on the cheek is noticed, more rudder and less bank is required.

Gradually, turns may be made smaller until a 2½-turn spiral in 1,000 feet is accomplished. Turning while volplaning may then be tried.

In gliding turns the airplane's nose should be kept below the line of the horizon. Climbing turns require the nose of the machine above the horizon.

STRAIGHTENING OUT

A few simple rules will serve to teach how to come out of a turn properly.

Theoretically, the rudder and aileron controls are brought back to central positions. In many airplanes, however, they must first be brought over to the opposite bank and centered when the machine is level. The stick control should be moved a trifle sooner than the rudder, and brought past center, being returned to central position when the rudder is at center and the airplane at a horizontal level.

Coming out of a steep turn these control movements are made greater, the stick being given a semi-circular action. Special care should be taken that the rudder is not swung over opposite too early, for this will throw the nose of the airplane up and an inward side-slip will result.

S-TURNS

These are a series of descending Figure 8s or S-turns, useful for landing in a restricted area. Two rules should be followed. During the entire turn the aviator should keep his eye on the landing spot selected and always turn toward that point. The turns are made increasingly smaller as the ground is approached for the final glide.

Turning near the ground should be avoided; speed should be maintained by keeping the nose down.

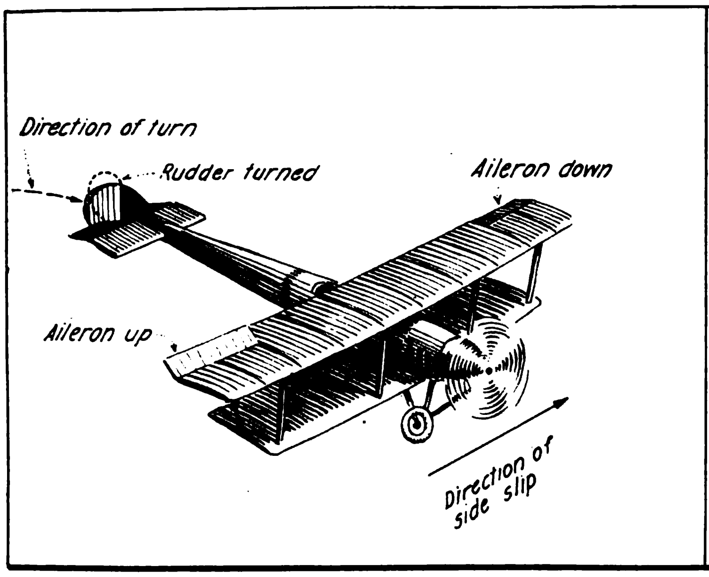


Figure 93—A too-flat turn, causing outward side-slip

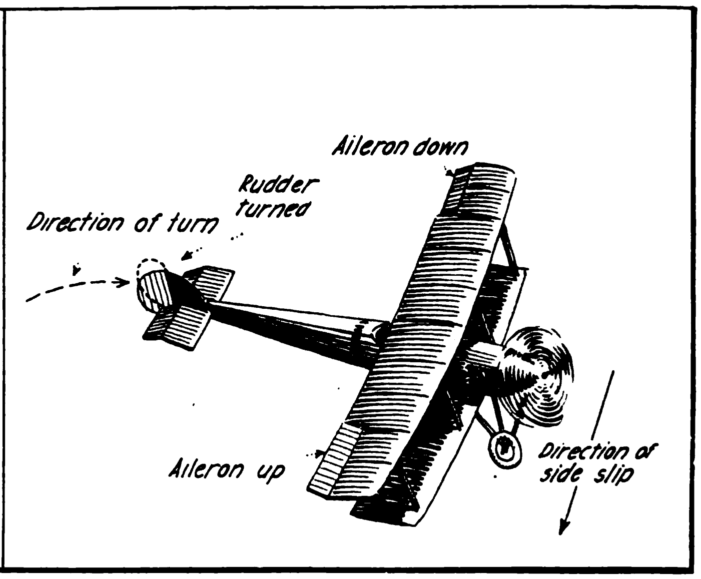


Figure 94—A turn too steep, causing inward side-slip

RIGHT OF WAY IN THE AIR

The student aviator should acquaint himself with the air rules of the flying school to which he is assigned. The courses are usually prescribed and the direction of circuits and pylon markings clearly stated. While slight variations may be encountered at various flying fields, the following general rules are almost universally observed:

MEETING AN AIRPLANE

When an airplane is encountered coming in the opposite direction, both machines keep to the right and pass at a minimum distance of 100 yards. See Figure 96.

OVERTAKING AN AIRPLANE

The faster machine coming from the rear maintains the same minimum distance, 100 yards, by steering clear, care being taken that the overtaking machine is not brought within the zone of influence of the backwash, for in the disturbed air rough going will be encountered. See Figure 95.

MEETING AT AN ANGLE

In a situation such as illustrated in Figure 97, where two airplanes approach at an angle, the aviator who finds the other machine on his right gives way.

LANDING SITES

The United States Army requires a flying field for testing aviators a minimum size of 800 by 100 feet. The general area of a field is about 9 acres, 200 yards square. Area allowances are added for obstacles, proportionately based on the obstacle's height, 12 times the height being added to the area, or 12 feet of field depth added for every foot of obstacle height.

The above regulation applies only to machines of slow landing speed. When fast airplanes are used, the 200-yard depth is added to as follows: 40 m.p.h., 60 yards; 45 m.p.h., 120 yards; 50 m.p.h., 360 yards; 55-60 m.p.h., 960 yards. These dimensions are based on landing and taking off against the wind.

Plowed fields, soft ground and ditches are dangerous to the inexperienced aviator and should be avoided as landing places.

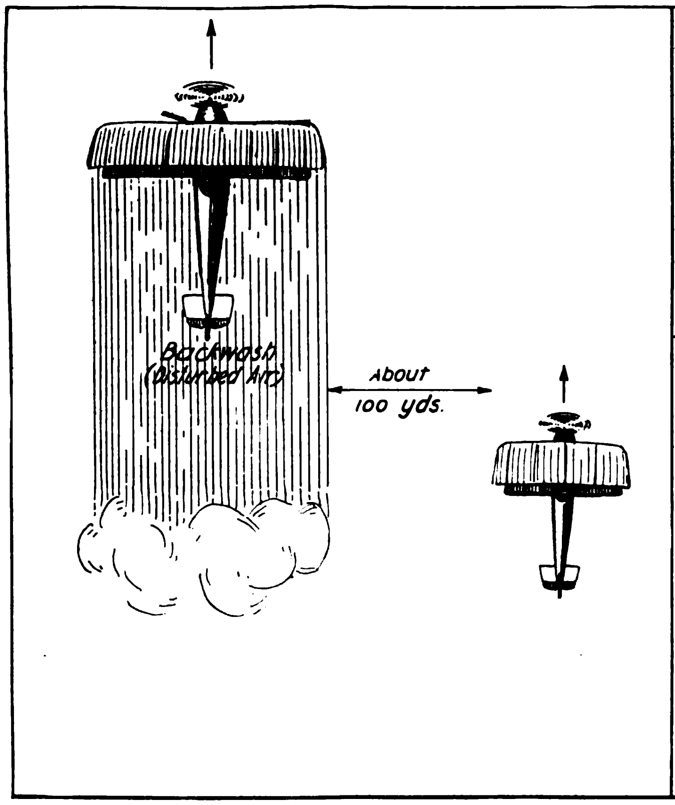
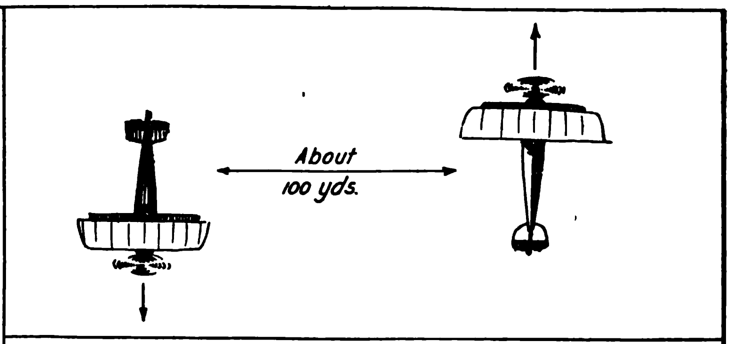


Figure 95—A fast machine overtaking a slower one leaves 100 yards interval between wing tips and avoids the backwash



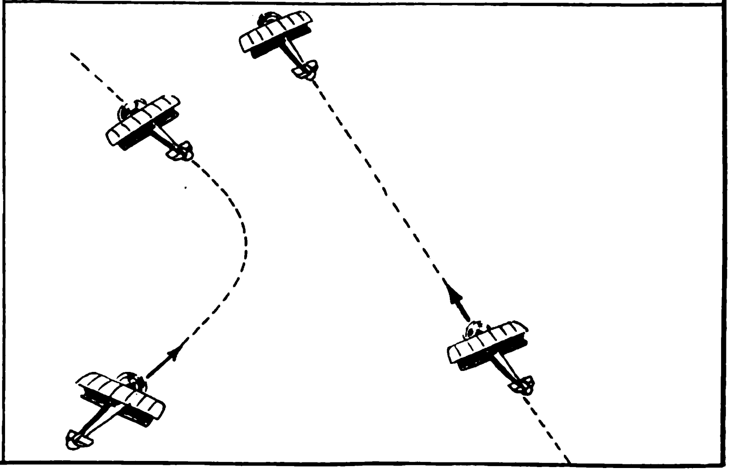


Figure 96 (Upper)—Interval for passing in opposite direction
Figure 97 (Lower)—Giving way when meeting at an angle

Canvas strips, 15 feet long and 3 feet wide, are usually employed to identify landing sites. These are visible to the pilot at altitudes up to 9,000 feet and indicate to the airman the direction for approach. The strips are arranged in the form of a T, the approximate outline of the airplane; a long strip is laid crosswise below the T to mark the point of contact with the ground, the machine being brought to full stop when on the T itself.

LANDING

Making a proper landing is one of the most difficult and most important tasks that confronts the student aviator. The success of the landing is largely dependent upon nosing the machine down at the proper distance from the landing field and choosing the proper gliding angle. Thus, if the angle is 1 in 6½ and the machine is at 200 foot elevation the maximum distance allowed for the descent would be 200 × 6½ = 1300 feet from the landing spot selected. If a greater distance is allowed, the machine is liable to fall short. A distance less than this maximum is preferred, since a spiral may be made to kill extra height and a correction of gliding angle made if the angle selected is not the best. All airplanes are designed to assume their gliding angle with power and thrust cut off.

OPERATION OF CONTROLS

When the descent is to be made the engine is throttled down to relieve strains on the airplane and insure flexibility of controls. Since the proper gliding angle is determined by the speed, the tachometer or the air speed indicator should register the determined speed within 5 miles an hour. The machine should be headed directly into the wind, the direction of which may be determined by observation of chimney smoke or flags below. When within 15 feet of the ground the tail control is gently pulled back, elevating the tail until the airplane is in its horizontal position for slow flight. This should be accomplished when 5 feet above the ground and the control then held; the airplane will thereafter descend without further assistance. The control should be held lightly, however, to correct for bumps.

When about to effect a landing a glance should be directed to the horizon or the indicator, and the aileron control used to keep the airplane laterally level. Swerving as the machine touches the ground is corrected by the rudder or the tail skid.

BAD LANDINGS

If when the airplane is about to land, it assumes the position of flight shown in Figure 99 it will bounce when it strikes the ground, the running gear breaking on the second impact. Also, if brought out of gliding position when too high off the ground it will drop, due to lack of speed, and the same break follow. These landings are known as the "pancake." The remedy is to speed up the motor to regain velocity and flying position, then throttle down and land.

The most dangerous landing is caused by failure to pull the airplane from gliding to flying position, the running gear striking the ground at a forward inclined angle. The motor must be instantly opened wide after the first bounce, flying speed being regained before the rebound.

A bad landing which severely strains landing gear and causes wheels to buckle, follows contact with the ground when the rudder is turned, causing a swerve, or when the airplane is not level laterally.

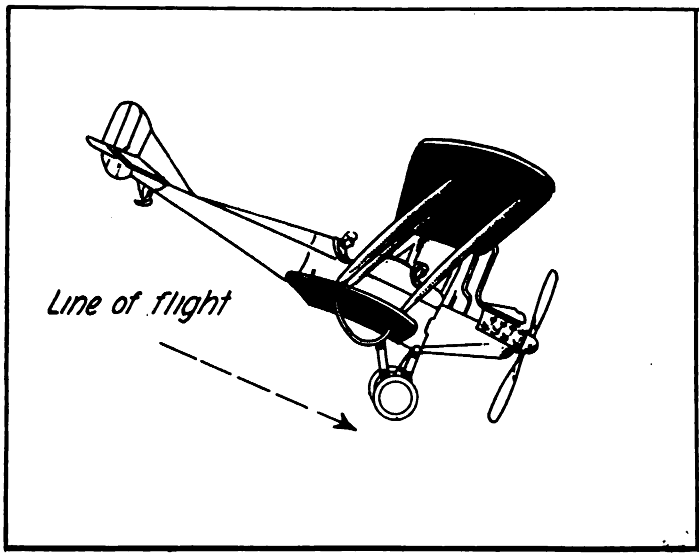


Figure 98—Airplane gliding to landing spot

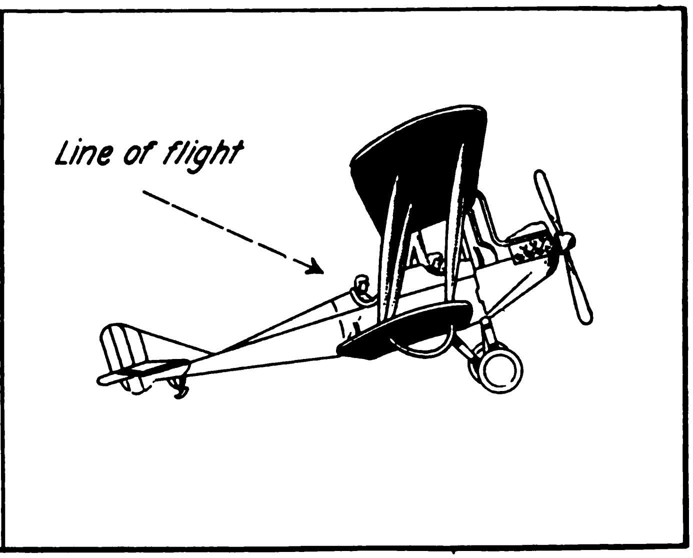


Figure 99—Incorrect landing position, resulting in "pancake"

Torpedoed!

(*Continued from page* 15)

was a large area of flaming gasoline marking the grave of another victim of German ruthlessness.

Distant explosions at frequent intervals informed us that there were other victims. We now began rowing toward a light on shore. There was a strong wind blowing against us, making rowing difficult and progress slow.

After two hours we beached our boat at Villa Joysa, a small Spanish fishing port, with a population of about eight thousand. Within the next half hour all the lifeboats, except one in charge of the third officer, reached shore. Local officials took us to a hotel where we were made as comfortable as possible under the circumstances.

None of us slept during the remainder of the night. About daybreak the crew of a Norwegian steamer, one of our convoy, arrived at the hotel. They, too, had been torpedoed. Later we learned that a British steamer, the third of our convoy, had met with a similar fate. The Germans had destroyed three of our number. The fourth was fortunate enough to escape.

In the early morning we were agreeably surprised by the arrival of the third officer with the rest of the crew. They had made for a different light and spent the night in a small village a short distance up the coast. After mustering the men it was found we had all survived with the exception of one sailor and a messman.

Later in the day the American Consul at Valencia sent his representative for us. We arrived at Valencia after dark and there we stayed until December 26th in rooms engaged for us by the Consul at the Pension Paris, an excellent hotel on the main street. Then we sailed on the steamer Manuel Calvo, of the Spanish trans-Atlantic Line, for New York via Malaga and Cadez.

Our adventures were not yet over. During the voyage we had extremely rough weather. The steering gear was disabled several times, and while this was being repaired we were in constant peril, being tossed about in the trough of the sea. It was at this time that several

(*Continued on page* 35)

Aviation News

Lieutenant Douglas ("Doug") Campbell

There is a happy coincidence in the fact that Lieutenant Douglas Campbell, of Mount Hamilton and France, should have been the first American trained aviator to become an "ace." Campbell is the son of the famous astronomer who has served for years as chief of the Lick Observatory, presiding over the most powerful telescope in the world. It was in this aerie that the future ace grew to manhood. After receiving an education in California young Campbell went east and became a student in the Boston School of Technology. It is such training as this which turns out aviators equal to any in the world.

Lieutenant Campbell is twenty-two years of age and has already received the much coveted Croix de Guerre. As a result of a recent successful encounter he also wears a wound stripe. He brought down his first boche on April 18, 1918. His record in air fighting has few equals. On the following day he bagged a second German, and a third on the 27th of the same month. An ace, it is hardly necessary to state, is an aviator who has downed five or more enemy airplanes in air encounters. It is not required that the enemy brought down should be actually killed, but there must be undisputed evidence that the enemy was brought down out of control.

One of Campbell's air battles was especially thrilling and attracted considerable attention even in France where such encounters are commonplace. He had engaged a German airplane at a high altitude. The boche soon got all that he wanted of the American's airmanship, and turning, beat an inglorious retreat. Campbell followed and was soon far over the enemy lines, which is always a hazardous thing to do. The battle was observed and five hostile airplanes joined in the engagement. By daring airmanship Campbell succeeded in shooting down one of these and making good his escape.

In a recent air battle Lieutenant Campbell was wounded, but he has already returned to active service. By the time this sketch appears our first American trained ace will probably have added new victories to his record.

* * *

Colossal Flying Schools Abroad

The New York Times' special correspondent, in conclusion of the first authorized description of the work accomplished by the American forces since they landed in France, writes of visits he paid to several of the new American flying schools. He says:—

"At another point some distance away I was equally impressed with both the work in progress and the working plans of one of the extensive so-called 'air service production departments.' This important centre of activity, which is typical of several now in course of construction, covers a tract of land over six miles long by a mile and a half wide, where the construction, assembling, testing, and repair of American airplanes will soon be going ahead full tilt on a scale never before known. The work splits into four main divisions—transportation, production, construction, and supply."

Lieut. Douglas Campbell, first American "Ace"

Trapshooting for Aviators

Trapshooting has been started for the benefit of the cadets at all aviation schools. The Government thus officially recognizes the value of a knowledge of trapshooting to the men who are training for this branch of the service. The most important part of their work will be shooting at a moving target, and trapshooting is designed to develop their skill in this direction.

* * *

Special Compass Courses

A number of commissioned officers of the Aviation Section, Signal Corps, have just completed special courses in compass adjustment and air navigation. The Department of Military Aeronautics recently organized a school at Camp Dick, Dallas, Texas, for this advanced instruction. The two courses were conducted at the same time and completed in two weeks. The two British officers who were the instructors have expressed themselves as pleased with the results accomplished and the spirit of the men. Captain S. T. Fripp, Royal Air Force, was in charge of the compass classes. This course was designed to give engineer officers special instruction in the adjustment and compensation of airplane compasses. Those instruments get out of order because of the local magnetic field set up by magnetos and engines and from the jarring due to rough landing. The students who took this course were selected from graduates of the engineering ground officers' school at Massachusetts Institute of Technology. The course in navigation was conducted by Naval Instructor W. T. Farr, R. A. F. It consisted in instruction in air navigation, or flying by dead reckoning, the method of flying followed when the ground is not in view. Each of the flying schools in this country was represented in this course by an officer who had had charge of cross-country flying. The officers who finished this training will now return to their respective flying fields to instruct cadets in the subject.

* * *

John D. Ryan Made Air Service Director

The Secretary of War authorizes the following:

With the concurrence of the President I have today selected Mr. John D. Ryan to act as Second Assistant Secretary of War in the place of Mr. Edward R. Stettinius, who is now in France. Mr. Stettinius will continue the special representative of the War Department in France, with full power to carry out special missions with which he is charged and will exercise as such special representative all the powers he has heretofore had.

Mr. John D. Ryan, as Second Assistant Secretary, is designated director of air service and is charged with the responsibility of procuring and furnishing to the Army in the field the matériel and personnel required for the air service, and is given supervision, control, and direction over the Bureau of Aircraft Production and the Bureau of Military Aeronautics with full power completely to co-ordinate their activities and to develop and carry out the air program.

The Post Office Department authorizes the following:

Cost of Operating Air Mail About Fifty Cents Per Mile

The first report of the comparative cost of the operation and maintenance of the Air Mail Service shows that the airplanes used in this service have broken all records for economy of gas consumption.

The total of all operating expenses of nine airplanes covering flights aggregating 7,234 miles, was $3,682. The total consumption of gas representing 113 hours and 8 minutes of flying was 1,377 gallons, which is $32.50 per hour—something over 50 cents per mile. The total cost of gas was $405 in flying 7,234 miles.

The best performance in flying was made by a Curtiss J-N-4 machine, which flew 26 hours and 40 minutes at a cost of $28.01 an hour and covered 1,719 miles at a cost of 43½ cents per mile. A plane equipped with an Hispano-Suiza 150 horsepower engine used approximately 8 gallons of gas per hour, and a plane equipped with a 400-horsepower Liberty motor used 17 gallons per hour. This shows 40 per cent less gas consumed than generally required for airplane engines of these sizes.

The calculation of operating cost includes departmental overhead charges, interest on investment, replacement of parts, deadhead time of mechanics, gas, lubricating oils, office force, motor cycles and trucks; rent, fuel, light, and telephone; pay of pilots, hangar men and mechanics.

The average consumption of gas for the nine planes was 12 gallons per hour.

* * *

The War Department authorizes the following:

Deaf Mutes Not Accepted as Flyers

The Division of Military Aeronautics has announced that applications of deaf mutes would not be accepted for war service in aviation and that directions have accordingly been issued to so inform hundreds of young men who have been encouraged to seek such enlistments.

The erroneous idea has apparently been deliberately circulated that since deaf mutes possessed little, if any, sensitivity of the inner ear, they would be little subject to dizziness, and, therefore, make good flyers. So persistently have these unauthorized statements appeared from time to time recently, that two separate investigations were started three weeks ago; one to determine the source of this misleading information and the other to make special tests of accuracy of deaf mutes in sensing motion.

The first investigation is not yet finished, but, so far, it is believed, that German propaganda is at the bottom of the agitation. The second investigation, completed by the Medical Research Laboratory at Mineola, L. I., included a number of tests during airplane flights to ascertain what effect, if any, the absence of the delicate balancing apparatus that exists in normal inner ears has upon persons who are without them.

At the Mineola tests the same plane was flown by the same pilots over the same course in each test. First, 10 normal men who had never flown were blindfolded, seated in planes, and told that after reaching a certain level the pilot would execute a number of evolutions which he, the passenger, was to record and to make particular note in which direction the plane had been turned to the right or left, up or down. The flights included stretches of level flying, climbing, left and right turns, dips and banks.

With very few exceptions the passengers with normal internal ears made correct notations of the different directions in which the pilots took them, noting each turn and dip correctly. Seven deaf mutes were then blindfolded, given the same instructions, and taken over the same course by the same pilots, to note the movements of the planes.

Being blindfolded, and minus, as they were, of the equilibrium of balancing organs in their ears, the deaf mutes failed to note changes of even as much as 90 degrees. Nor could they differentiate the deepest right from the deepest left banks, nor notice the difference between climbing or diving in a practically vertical position. Some of the passengers with normal ears, on the other hand, reported changes in direction as slight as 5 degrees, and were apparently sensitive to the slightest deviation.

After the tests, several of the deaf mutes admitted that they had been entirely in the dark as to their position while in the air.

* * *

The Aviation Program

A pamphlet has recently been issued by the Smithsonian Institution containing extracts from the Report for the year 1917, of the War Cabinet of Great Britain relating to supply of aircraft.

The description given of the difficulties in the way of obtaining a supply of aircraft is so accurate and is so general in its application to all countries that it is believed it should be given as wide a circulation as possible in America. Its application to the American aircraft situation is evident if we remember that Great Britain has been at war since August, 1914, and that every resource of the country, famous for generations as the center of mechanical developments, has been applied to the problem of the production of aircraft. This enables us to appreciate more clearly the progress made by the United States in 1917-18.

"It is rather the fashion to criticise the quality of our machines. Most of the critics, however, are ignorant of the technical and manufacturing difficulties which have to be overcome in order to keep up a constant and increasing supply of the most up-to-date machines. Not only are the technical difficulties and the resultant research and experimental work formidable in themselves, but the task of building up in war time, without seriously affecting the requirements of other services, a new industry of a most highly skilled character necessarily puts a heavy strain upon the organizing and manufacturing ability of the country.

"The science of aeronautics is in a state of constant and rapid development; improvements in engines, aeroplanes and their numerous accessories are constantly being worked out. But the interval between the discovery of an improvement and its introduction into the service is, owing to technical considerations, very much longer than is commonly supposed. Experience shows, that, as a rule, from the date of the conception and design of the aero-engine to the delivery of the first engine in series by the manufacturer, more than a year elapses; the corresponding period for an aeroplane is about one half as long. Consequently, plans have to be laid for a long period ahead, and these plans are liable to be upset by many uncertain factors. The hopes based upon the promising results given by the first experimental engines of a new design are frequently disappointed owing to difficulties of bulk manufacture or to defects only developed after long trial in the air; new types of aeroplanes favorably reported on when first tried are found on longer experience not to give complete satisfaction, and yet it is impossible, if we are to keep ahead in the keen struggle for aerial superiority, to wait for full experience before placing orders. Risks must be run, and new types must be adopted at the earliest moment consistent with reasonable assurance that they will constitute a substantial improvement on what is already in use. Orders must be placed, moreover, for considerable numbers and for delivery over many months, as the large output required for our present flying services can

(*Continued on page* 41)

Signal Officers' Training Course*

A Wartime Instruction Series for Citizen Soldiers Preparing for U. S. Army Service

By Major J. Andrew White

Chief Signal Officer, American Guard

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Seventeenth Article—The Signal Corps and General Coast Defense

THE United States, unlike other great nations of the world, has never established, and may never need to establish, permanent fortifications on the land frontiers, since the real frontiers are the seas. But even without the obligation of defense against neighbors to the north and south, the vast extent of the coast imposes upon the country a duty which can but grow greater as population and wealth advance, and as the power and number of commercial ships and of navies increase. Types, speed, and size of ships are bringing alien shores yearly into more intimate relations and are making sea attack more easy, more swift, and more dangerous than ever before. The weight and range of floating batteries, the number and speed of merchant vessels and their great transporting power, the swarms of rapid and dependable auxiliaries, the submarine, the airplane, and the dirigible, leave all but strongly protected coasts without the chance of defense in war, except by airships and submarines and of course the mobile army, and fixed defenses in addition to a navy whose duty at the outset may call it into distant seas. The probability of the absence of the navy at the very moment when coast protection becomes most necessary is so strong as to amount to a certainty.

Regarding the defense of the seaboard of the United States, it appears clear in retrospect that the inertia which for years followed the close of the civil war and the later days of tranquility, prevented the making by the nation of any serious effort to protect the coasts of the country from foreign attack until some thirty years ago, when indifference began to give way to the demand for an efficient navy. The growth of the navy in turn emphasized the need of protected harbors and of permanent defenses; and as the fortifications required soldiers to man them attention was at last directed more and more strongly to the personnel of the defense. At last the coast artillery was given a working, if still a skeleton, organization; efficient armament and satisfactory equipment were added; systems of fire control and directions were devised and at least partial lines of information installed. Finally it began to be understood, though dimly at first, that defenses themselves must be defended; that the eyes and the hands of men must assist in coast protection and that two important factors of the defense, namely, the coast patrol and the mobile army; must form a front for any adequate system of protection.

For convenience in considering what follows, it is assumed that in war the coast defense, which combines the military and naval dispositions and operations necessary to resist attack on any part of the coast line, may be divided into six factors, each related to the other in operation and all dependent upon co-ordination of action to bring out their full value. These are, first, the fixed and floating defenses of the artillery, consisting of the armaments, submarine defenses and materials, coast and scout ships, and to some extent air craft, torpedo, submarine, patrol, and picket boats; the personnel, including all troops assigned to duty in connection with the fixed defenses. Second, the general defense troops of the regular or volunteer army, or of the organized militia, not including the supports of fixed positions. Third, the air service, including the necessary aero squadrons of various types, with their auxiliary tractors and the dirigible when used for coast patrol and defense. Fourth, the coast patrol, including the coast guard. Fifth, the service of the lines of information; that is, the Signal Corps of the army. Sixth, the navy.

Although each of these factors supplements the others, it is evident that the one which binds them all into a working whole, and without which the other five will have rather less cohesion and connection than so many reeds shaken by the wind is the Signal Corps in control of the lines of information and the service of air craft.

To arrive at a proper understanding of the extent and character of the lines of information necessary to keep in brain touch the elements of the defense of a great seaboard like our own, it will be well to first outline the general scope of the defense and to indicate the part played by the other factors in war.

The first of the factors of defense to be considered is that of the fortified positions.

In general terms, the permanent defense of a coast or harbor consists in the adequate protection of a number of distinct positions, which from their importance to the country or value to the enemy must be guarded against injury, occupation, or capture. Such positions are either actually or potentially guarded permanently by a number of fixed artillery emplacements, the fighting or tactical units of which constitute a chain of command. The artillery defense as a whole is made up of a series of tactical areas, each measurably complete and independ-

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*The articles in this series are abstracted from the complete volume, "Military Signal Corps Manual," by the same author.

ent in itself, but separated usually by considerable distances of coast from the others, and the whole kept in touch by lines of information, usually commercial, which form a chain encircling the country.

On the coasts of the United States there are eighty-one separate forts where modern defenses are installed or are in process of installation; in the Philippines there are six; in Hawaii, four; in the Canal Zone, five; a total of ninety-six. It is evident, therefore, that the fixed defenses alone required a vast number of lines of information and, further, that for the purpose of control of its vast coast line these positions must be kept in communication not only with great centers of population and with the capital of the country but with each other, and that under certain probable conditions of war the chain of defense from Portland to Galveston, from San Diego to Puget Sound, or perhaps from Quoddy Head to the Straits of Fuca, must be kept in constant and immediate touch by telegraph, telephone, or radio. This, of course, is largely a problem for the existing commercial lines to solve.

The Mobile Army of Coast Defense

It is probably evident to all who have considered the matter that the most necessary factor of the land defense of the coast is the mobile army, together with its auxiliaries. Even to the unthinking it must be obvious that without such forces there can be no real and substantial protection for the coasts, except at those positions which have been selected beforehand for fortification, which of necessity will be few in number. Even if these fixed defenses could stand alone, which they cannot do, they will of necessity form but a partial and interrupted protection to an extended seaboard and will leave open to attack many important towns, serviceable harbors, and landing places that may be used by an enemy as a base or as coaling and supply stations. The fortified positions are really harbor defenses only. It is clear also that a country with some 5,700 miles of coast line offered to attack, indented with innumerable minor harbors and anchorages and dotted with important towns that invite destruction, cannot protect all its vulnerable points by costly and extensive armaments; as a consequence, minor positions must be otherwise defended or left to shift for themselves. While the defending navy remains within reasonable distance of the coast the minor positions will be free from danger, but a navy, if efficient, will not remain at home. In a serious war, therefore, protection for the less important positions must fall to the care of such of the floating defenses as may be withheld from distant seas; to the troops of the mobile army, aided by such land batteries as can be hastily constructed and armed; to the submarine and to the air craft. Such partial defenses may not prevent attack and local injury, but they can, at least, prevent destruction and an occupation that may provide the enemy with a naval base and perhaps threaten invasion of the country at large. Protection against this danger rests with the mobile army alone, once a foothold has been established on our coast.

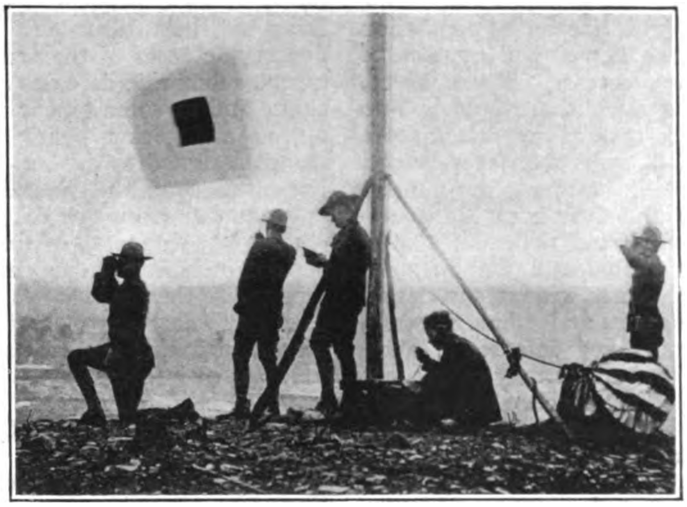
The need of a mobile army in coast defense is not, however, confined to the protection of the lesser positions and harbors unprovided with effective fortifications and armament, for it is to be remembered that coast fortifications of today, unlike the permanent works of an earlier time, look only toward the sea, and of themselves are helpless against land attack; hence they must be protected at flank and rear from approach by hostile troops and landing parties.

In these days every serious sea attack, to be successful, must be accompanied by land operations, a fact well illustrated by the fall of Tsingtau and especially by the desperate sea fights of the Dardanelles and of the Gallipoli Peninsula and the subsequent land attacks. It is evident that though ships unsupported may cause great damage and even destroy cities or fortified positions, they can produce but little effect upon the ultimate result of a campaign unless combined with land operations, by means of which the defense is not only destroyed, but overwhelmed, the objective occupied, together with the surrounding regions.

It appears, then, that the country must be prepared to prevent throughout the vast extent of its seaboard the seizure and occupation of any one of many important points, both fortified and unfortified, and of all of its harbors and landing places useful to an enemy. This implies the existence of a mobile force so placed and so large and effective in organization as to insure, on the one hand, the safety of exposed positions by proper dispositions of troops immediately needed; and, on the other, by concentration of the major part of these mobile troops in reserve at strategic positions of the coast or possibly of the other frontiers as to permit the use of an overwhelming number of defense troops at any threatened point.

In the defense by a mobile army the plan adopted may well be somewhat as follows: The Atlantic, the Gulf,

A signal station for visual communication captured from the Germans by American signalmen



Men of the 104th Field Signal Battalion, U. S. Army, communicating by wig-wag and wireless telegraphy at Camp McClellan, Anniston, Alabama

Where a plank must serve to cross the stream over which telegraph lines are thrown and the Pacific seaboards will be divided into defensive areas, the extent and boundaries of which will depend upon strategic, geographical, and economic conditions. These areas will not, as a rule, be coextensive with military departments, since they depend upon different conditions and lie mainly along the sea. They will be controlled by their own general officers, acting presumably under one chief. In each area there will exist in war a mobile force adequate not only for its defense proper—that is, for land defense of fixed positions, unprotected harbors, and other vulnerable points within the area itself—but for service with other troops mobilized and held as a general reserve. Within defensive areas there will be placed a sufficient number of men of the regular army, of the trained citizenry, and of the organized militia of the state or neighboring states to form a nucleus of the force required. In addition to the aero squadrons, which form part of a division of the mobile army, there should, of course, be gathered together all of the flying men who can be brought into service with the militia or the volunteers, and to them should be allotted the duty of watching the coasts, so far as practicable.

It should be evident that of this force the men most needed in the preliminary work of the defense are not coast artillerymen alone, but engineers, and signal troops, especially of the aviation section, since the first step in mobilization is the establishment of lines of information, of which soldiers alone should be in control, and the training of airmen.

The mobile troops of the coast defense obviously require ample strength in engineer and signal troops, field and horse artillery, and a due proportion of cavalry to erect and defend the field works on the land fronts of fixed positions, to establish and maintain lines of information, to check sudden attempts at coast landing, and to perform the duties of mounted troops in the field and for air service.

It is certain that if so trained the small quotas of state troops, are of the utmost value to the defense at a time when the lines of information—the telegraph, the telephone, radio and air service—are urgently needed in the organization, disposition, and control of newly organized levies. Together with the signalmen of the regular army, they may well undertake the organization of additional signal troops from the citizenry called to the colors.

If it becomes necessary to put forth the strength of the country by calling to the colors the larger part of the mighty reserve available for national defense, it is certain that the total number of men of the ultimate levy will be so enormous that occasion for mobilization of the whole can hardly arise. But though the *leve en masse* may never be resorted to in this country, a force called to the national defense in a great war is no small thing, and the work of turning it into an efficient army and of supplying it with an adequate force of technical troops properly equipped for the field requires the best efforts of every trained man of the service.

General levies are certain at first to be weak in these very arms, since they are of necessity almost nonexistent with the organized militia of many of the states in ordinary times. Lack of the assistance of technical troops hampers the defense, gives to the troops little mobility, and compels them to remain tied to their base or semi-permanent camps. This condition will doubtless be corrected as time goes on, but its existence at first multiplies the lines of information and the duties of signal troops. It is certain therefore that the communications by which the first line and the reserves will be linked together and to the permanent works should from the early efforts at concentration be ample and effective, and so continue, for without them the whole army of the defense becomes a mere aggregation of inert units.

SUPPORTS

A third class of troops organized are, if not large in number, at least of vital importance in coast defense; they are the support of artillery positions proper. These men, placed at stations suitable to the defense of fixed positions against land attack, act in concert with the coast artillery and are under the immediate command of artillery officers, presumably of posts or districts, since it is evident that they must be kept as directly in touch with the officers fighting the positions as are the marines aboard ship. The supports may well be drawn from the mobile troops proper and be composed of the first and best men called to the general defense; that is, of such troops of the regular army as can be assigned to the duty and of the flower of the organized militia. Made up almost entirely of infantry and field artillery, with as many machine-gun batteries as may be available, there should be added a far larger proportion of signalmen than is usually considered necessary for an army in the field, since upon these men falls the service of information not merely with other elements of artillery defense, but with the fixed positions, the mobile troops, coast guard, and with the navy.

The lines of information of these supporting troops are those of the field army. They will be mainly dependent upon the buzzer, airplane—or perhaps the dirigible—the radio, field telegraph or telephone, and visual signaling.

In considering defense against invasion, it should appear that the mobile troops indicated will stretch over many miles of country and operate under widely varying conditions. Even more than for a well-organized army in campaign, therefore, the lines of information for the, at first, somewhat unorganized forces of the general defense must be ample and widely extended.

Indeed, except in emergencies, these lines are more necessary in the early days of the defense than later when the machine moves smoothly, but at all times the mobile troops, without an adequate service of information, have rather less direction and mobility than a collection of tortoises. Properly laid, the lines of information not only form a network throughout the defense area but tie each theater of operations to the others and provide the entire army with the lines heretofore shown to be essential in the field.

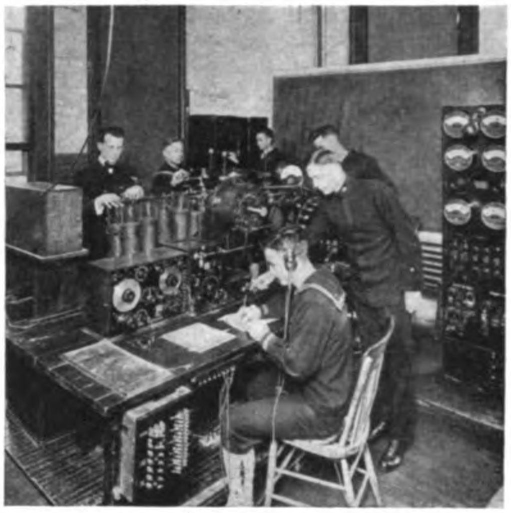
With headquarters of the defense and those of mobile troops fixed at the places best suited tactically for the purpose—and it is reasonably certain that these positions lie at centers of commercial activity—they will be distant from the camps of divisions and brigades and still farther separated from the smaller commands and detachments, from the artillery headquarters and from observation stations and outposts of coast defense. Yet with all these commanding officers of the mobile forces must be kept in constant and immediate touch, as well as with the military commanders of departments, should the latter not be in command of the general defense—and with Washington. In turn, army, division, and brigade headquarters must be kept in communication with dependent and outlying commands; these with the observation stations and coast patrol; and the latter given the power to communicate readily with the floating defenses, with artillery districts, and with ships.

For the mobile coast army the systems of information needed are even more extensive and varied than is considered necessary for a field army in campaign; and it follows that the proportion of signal troops to line soldiers in coast defense should be increased.

It is hopeless to suppose that the Signal Corps of the regular establishment can ever supply more than a leaven for the mass of men needed, especially for the air service, or even that the militia possessing signal troops of ap-

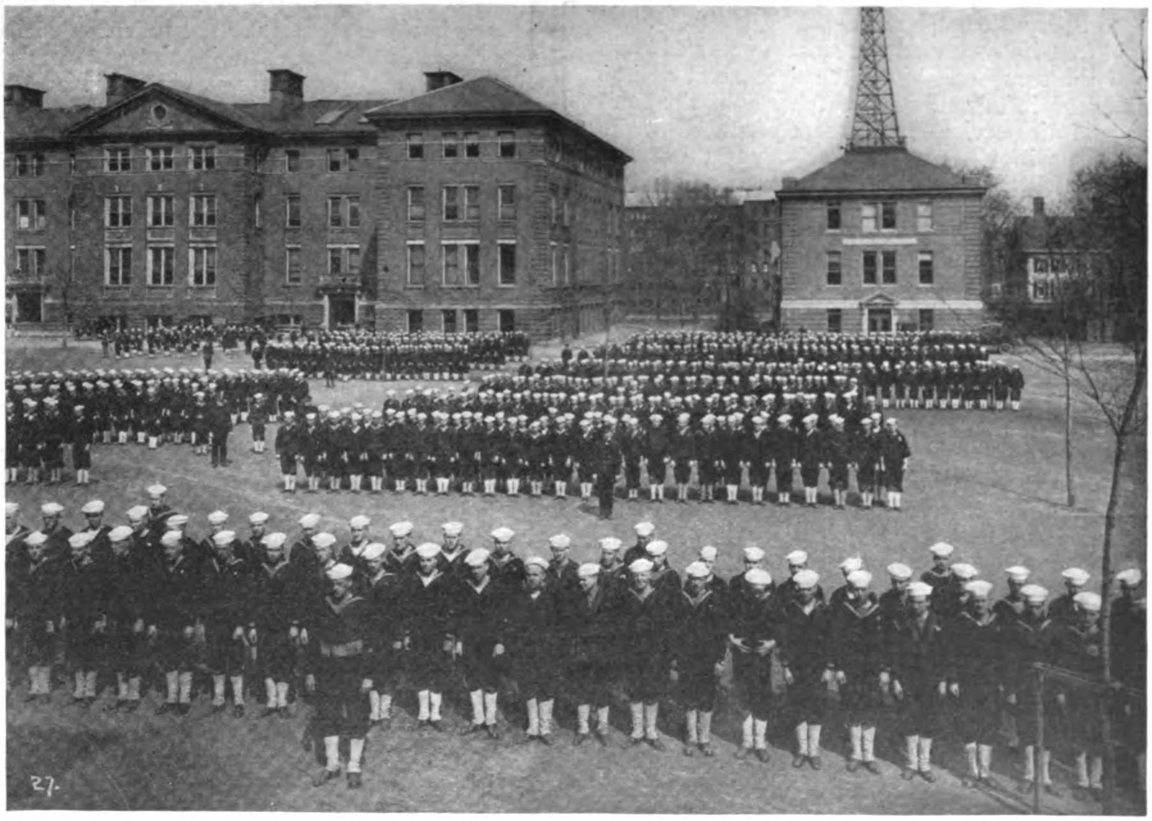
Harvard Radio School

Photos: Edwin Levick



Above: receiving instruction in manipulation of various types of tuners in a room which presents to the student the many parts of assembled wireless sets

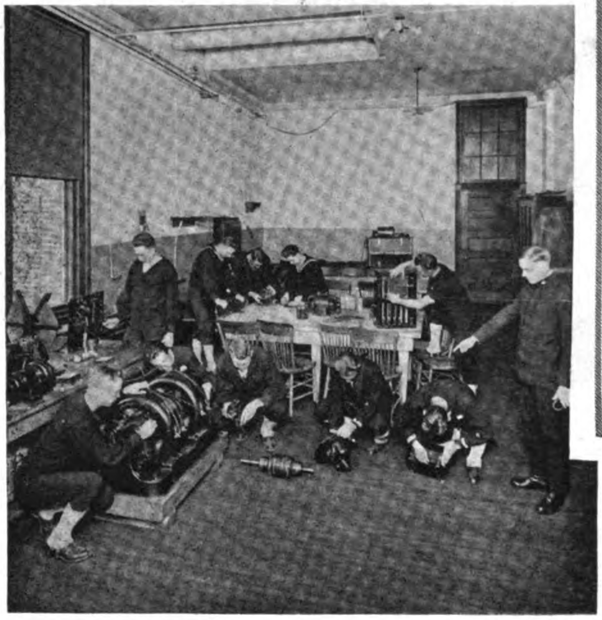
To the left: an outdoor demonstration of portable radio equipment, a suitcase pack set and hand generator in field operation

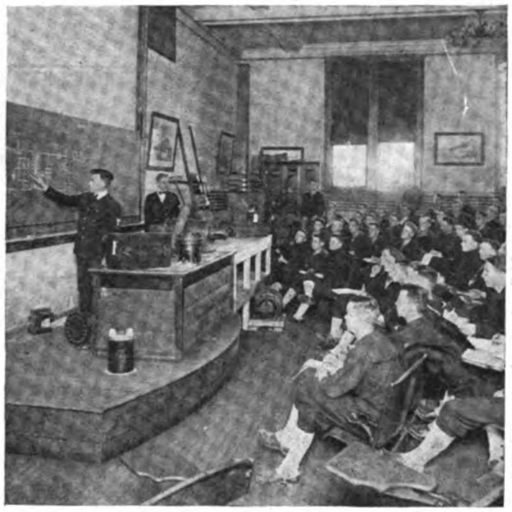


A stirring sight is the assembly for inspection and review with historical buildings and laboratories forming a background

Six Views of Some of the Thousands of Young Men Who are Training at Cambridge, Mass. as Wireless Operators for the U. S. Navy.

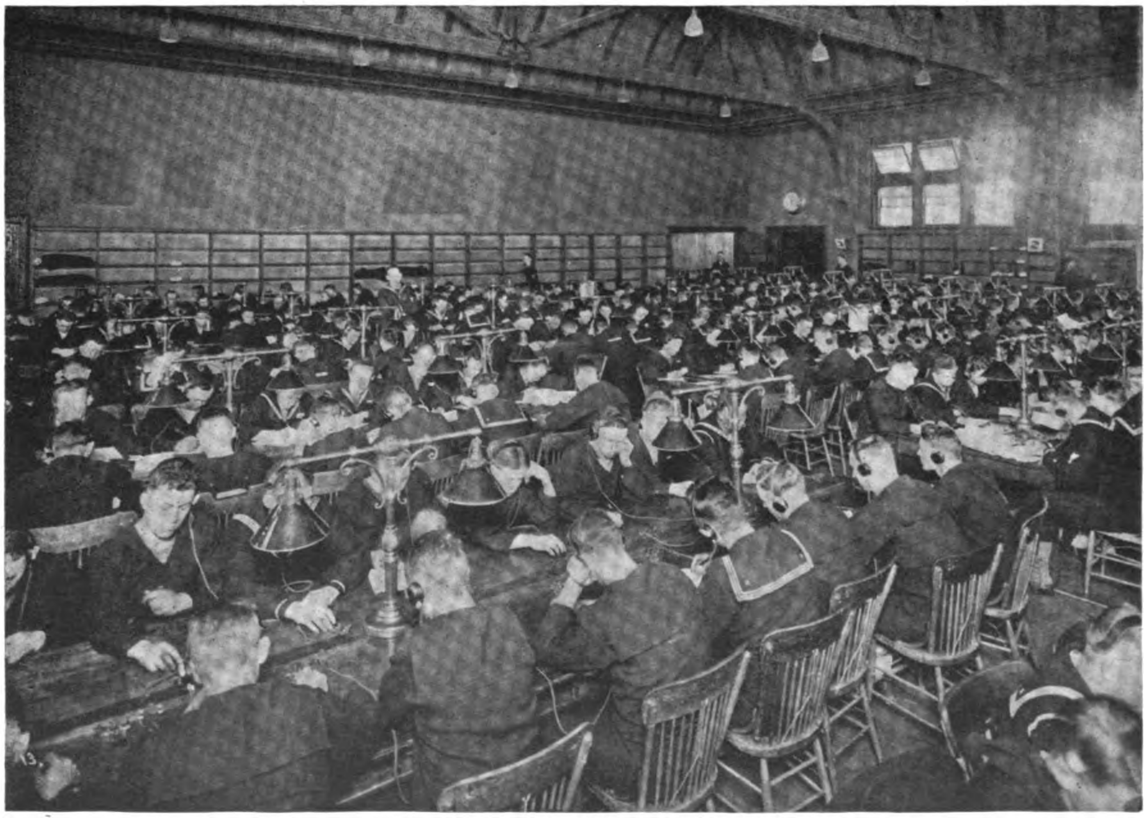
(See also page 44)





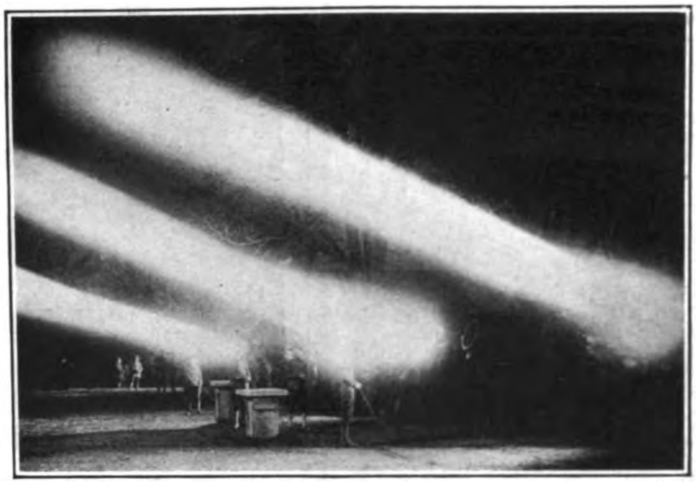
Above: a class of stalwart youths intent on mastery of the circuits of a wireless telegraph set

To the left: the practical application of class-room instruction carried out in the assembling room, where motor generators, gaps and transformers are taken apart and put together



One class of 800 boys learning how to send and receive in the code instruction room

proved efficiency can provide more than the framework of the organizations required. The signal troops mobilized for war must be filled in by men drawn direct from civil life. But excellent and abundant as the material for these troops undoubtedly is among the men engaged in the electrical and mechanical pursuits, and from the few trained in airplane work, such men before they can be of any real value must be made into soldiers. The Signal Corps of the army will never have the numbers or the opportunity to take upon itself alone this training, and the assistance of the organized militia and of suitable and willing men in civil life must be asked and given. The training must be quick and effective, and therefore be performed by men who have themselves been drilled in peace in the methods of the Signal Corps of the army. Unfortunately, trained militiamen and airmen are at present few and are confined to a small number of states, and even where signal organizations exist, they are not always given, be it said without disparagement of the troops themselves, the strength in numbers, the equipment, nor, up to now, the training to make them immediately valuable in coast defense.



Powerful searchlights such as these are now vital to coast defense, the problems of which and their relation to the Signal Corps are discussed in this article

Service of Aircraft in Coast Defense

A third and very important factor in coast defense is the service of air craft, and it is becoming increasingly evident that in addition to lines of information laid or worked on land, there must now be recognized and carefully considered the part played in coast defense and observation by aerial fleets. It is not intended here to speak of the airplane merely, but to suggest also the potential value of the lighter-than-air craft, whose special use is now thought to be in scouting or reconnaissance work, which means, of course, its use as a coast patrol.

Divided into areas or districts patrolled by dirigibles or airplanes, all communicating back to central stations and maneuvering far out to sea, such scouts should make impossible a hidden approach or surprise attack by an enemy. The captive balloon also finds a useful place in service of this kind. But the time has not yet arrived to indicate definitely what form the defense air service will take. It has been suggested that the coasts of the country be divided into sections or areas, each of which should contain an aerodrome or center from which scouting land and sea planes could operate at sea and send reports by radio, if satisfactorily installed, to the central stations regarding the movements of enemies' or friendly ships.

Whether this air patrol shall eventually be installed and conducted by the army, the navy, or the coast guard is undecided, and in the present condition of affairs is not a matter requiring consideration here. There is involved, however, a vast and important field of Signal Corps work, not alone in this aviation service, but in the transmission by wire, radio or otherwise, news received from aircraft at central stations, often located at isolated points to the proper headquarters.

The fourth factor of the coast defense, and that one which depends for its value, if possible, even more closely upon the lines of information than others, is the coast patrol, or coast guard, as it is now called.

To a student of the present condition of our defense it will perhaps appear that the important subject of coast observations, or coast patrol, has not received from the army the attention it deserves. Radio and signal stations have been erected within artillery districts, and by the navy; but great stretches of coast, often containing good harbors, landing beaches and magnificent lookout stations remain without the means of rapidly communicating their news to the telegraph and telephone lines of the country. At many of the lookout stations valuable information of friend or enemy at sea may be gathered, yet they remain in general unprepared for service in war. The need of the co-operation of the trained men and efficient equipment prepared by the Signal Corps for just this kind of work is important.

Without the full co-operation of the Signal Corps of the army and the participation of troops trained in the service of lines of information and in the use of the airplane; the establishment of signal stations, and telegraph, telephone, and buzzer lines; cables; the captive balloon and the dirigible, it is hard to see not merely how the best methods of gathering intelligence in war can be employed by a coast guard, but how, when so gathered, the information obtained can be transmitted to the centers of control, to artillery fixed positions and their auxiliaries, and to the mobile army from distant observation stations, coast islands, and lighthouse, or from the floating auxiliaries and passing ships, with the speed and certainty which alone make such information valuable.

In the November Issue

A special feature of greatest value to men in the aviation section of the Signal Corps.

Cross-Country Flight

Its difficulties and the equipment required—How a compass is adjusted—Military maps and how to read them—and other practical information for the military airman.

Signal Corps News

Citations for Bravery

The following is a list of officers and men cited by the Commanding General of the French Army in which our First Division is serving, for heroism and gallantry in action displayed during recent operations at Cantigny.

PVT. JOHN J. POOLE, distinguished bravery in repairing telephone lines under heavy shell fire and in maintaining communications.

FIRST LIEUT. VOLNEY B. BOWLES displayed great courage in stringing wire and in maintaining communications under exceptionally heavy shell fire.

PVT. (FIRST CLASS) OSCAR A. BONDLID, great courage and bravery in repairing, under heavy shell fire a telephone cable between the division machine-gun officer and his group commander. Although hit by shell fragments, he continued his work regardless of danger.

CAPT. WILLIAM T. CROOK, displayed courage in maintaining telephone communications and great efficiency in enabling the command to follow, all the time, the progress of the fighting.

PVTS. ROY SAGE AND EARL ARNOLD, worked 12 hours on the night of May 27 laying telephone lines which were cut three times, compelling them to return for more wire under terrific shell fire and gas bombardment.

PVT. CHARLES D. FAIR, was killed while repairing telephone lines under shell fire.

PVTS. JOSEPH BECK, ERNEST U. BECKER, HENRY C. FRANZ, EDGAR A. HARTMEN, ROBERT E. CARSON, MIKE VUJNOVICK, for repairing telephone lines under shell fire; all wounded.

* * *

Staff Duty in Washington

General Orders, No. 53:
III. Induction into military service for duty with the General Staff and bureaus in Washington is authorized only in cases of men technically qualified for such duty, physically disqualified for general military service, and physically qualified for special and limited military service only.

* * *

Service and Wound Chevrons

General Orders, No. 53:
IV. Subparagraphs (c) and (d), paragraph 1, and paragraphs 7 and 8, General Orders, No. 6, War Department, 1918, are amended to read as follows:
1. * * * (c) War-service chevrons.

A gold chevron of standard material and design, to be worn on the lower half of the left sleeve of all uniform coats, except fatigue coats, by each officer, field clerk, and enlisted man who has served six months in a theater of operations during the present war as an officer, field clerk, or enlisted man of the armies of the United States, and an additional gold chevron for each six months of similar service thereafter.

A sky-blue cloth chevron of the same pattern and worn in the same manner as the gold chevron by each officer, field clerk, and enlisted man who has served under the conditions prescribed for the gold chevron, but has left the theater of operations prior to the completion of six months' service therein. Should a person subsequently return to the theater of operations for duty therein, the blue-cloth chevron will be replaced by the gold chevron upon the completion of a total of six months of service in the theater of operations, after which only gold chevrons will be worn to indicate war service. The right to wear war-service chevrons is limited to those officers, field clerks, and enlisted men whose official duty requires their presence in a theater of operations, as distinguished from those who may visit such a theater without having been ordered thereto for duty. The term "theater of operations" is as defined in Field Service Regulations, 1914, as corrected to April 15, 1917.

War-service chevrons of the same material and design and similarly placed will be worn on the coat, overcoat, or waist of their prescribed uniform by all other uniformed personnel of the authorized Military Establishment. They will be worn under the same conditions as prescribed for officers, field clerks and enlisted men.

(d) Wound chevrons.

A gold chevron of pattern identical with that of the war-service chevron, to be worn on the lower half of the right sleeve of all uniform coats, except fatigue coats, by each officer, field clerk, and enlisted man who has received or who may hereafter receive a wound in action with the enemy, or as the result of an act of the enemy, which necessitates treatment by a medical officer, and an additional chevron for each additional wound; but not more than one chevron will be worn for two or more wounds received at the same time. Disablement by gas necessitating treatment by a medical officer shall be considered to be a wound within the meaning of this order.

Wound chevrons of the same material and design and similarly placed will be worn on the coat, overcoat, or waist of their prescribed uniform by all other uniformed personnel of the authorized Military Establishment. They will be worn under the same conditions as prescribed for officers, field clerks, and enlisted men.

A group of officers of American Guard, N. Y. Division, in training camp at Bear Mountain. Left to right seated: Captain C. Jones, West Point; Major C. S. Nyman; Major W. H. Elliott, Adjutant General; Major J. A. White, Chief Signal Officer (Editor, The Wireless Age); Captain W. Farrington, Post Adjutant; Seated, in front: Captain C. P. Young, West Point, and Captain W. R. Brewster, West Point. Standing, left to right: Lieutenants Solomon, Cogan and Schloss; Captains Horn and Bloom; Lieutenants Tropani, Henle and Keeler

Wartime Wireless Instruction

A Practical Course for Radio Operators

By Elmer E. Bucher

Director of Instruction, Marconi Institute

ARTICLE XVIII

(*Copyright*, 1918, *Wireless Press, Inc.*)

Editor's Note—This is the eighteenth installment of a condensed course in wireless telegraphy, especially prepared for training young men and women in the technical phases of radio in the shortest possible time. It is written particularly with the view of instructing prospective radio operators whose spirit of patriotism has inspired a desire to join signal branches of the United States reserve forces or the staff of a commercial wireless telegraph company, but who live at points far from wireless telegraph schools. The lessons to be published serially in this magazine are, in fact, a condensed version of the textbook, "Practical Wireless Telegraphy," and those students who have the opportunity and desire to go more fully into the subject will find the author's textbook a complete exposition of the wireless art in its most up-to-date phases. Where time will permit, its use in conjunction with this course is recommended.

The outstanding feature of the lessons will be the absence of cumbersome detail. Being intended to assist men to qualify for commercial positions in the shortest possible time consistent with a perfect understanding of the duties of operators, the course will contain only the essentials required to obtain a Government commercial first grade license certificate and knowledge of the practical operation of wireless telegraph apparatus.

To aid in an easy grasp of the lessons as they appear, numerous diagrams and drawings will illustrate the text, and, in so far as possible, the material pertaining to a particular diagram or illustration will be placed on the same page.

Because they will only contain the essential instructions for working modern wireless telegraph equipment, the lessons will be presented in such a way that the field telegraphist can use them in action as well as the student at home.

Beginning with the elements of electricity and magnetism, the course will continue through the construction and functioning of dynamos and motors, high voltage transformers into wireless telegraph equipment proper. Complete instruction will be given in the tuning of radio sets, adjustments of transmitting and receiving apparatus and elementary practical measurements.

This series began in the May, 1917, issue of The Wireless Age. Beginners should secure back copies, as the subject matter presented therein will aid them to grasp the explanations more readily. If possible, the series should be followed consecutively.

THE VACUUM TUBE OSCILLATION DETECTOR

(1) A heated metal in a vacuum gives rise to the emission of small particles of electricity called **electrons.**

(2) These particles of electricity are **negatively charged** and may be influenced by an electrostatic or an electromagnetic field.

(3) About 1800 electrons constitute an **atom,** which is the smallest particle of matter that can take part in chemical action.

(4) The **normal atom** is assumed to consist of a definite number of **electrons** grouped about a nucleus having **a positive charge** and so long as none of the component electrons are driven from the atom, it possesses no detectable electrical charge.

(5) If electrons are driven from a normal atom, **ionization** is said to take place and the atom then possesses **a deficiency of negative electricity.** It therefore takes on the characteristics of a positively charged body and is then called a **positive ion.**

(6) If electrons are added to a normal atom, the latter possesses an excess of negative electricity and it takes on the properties of a negatively charged body.

(7) It is believed that the **flow of current** in a conductor is the **movement of a great number of electrons.**

(8) Electrons driven from an atom by raising, for example, the temperature of metal to incandescence, may act as carriers of electricity between two metallic elements in vacuua.

THE OSCILLATION VALVE

(1) The electronic emission of an incandescent lamp filament can be put to a useful purpose in connection with the reception of radio telegraphic signals. They were first employed in this way by Dr. J. A. Fleming.

(2) Fleming's original oscillation valve comprised a **lamp filament** and a **metallic plate** sealed in an exhausted tube. He found that when the filament was brought to incandescence, **electricity could readily flow from the plate to the filament but it was opposed in the opposite direction**; that is, the tube proved to be an efficient **rectifier** and it performed this function at frequencies up to several million cycles per second.

(3) It should be kept in mind here that in accordance with the electron theory, electrons flow oppositely through a circuit to the formerly accepted assumption as to the flow of current. For example in terms of the electron theory, negative electricity flows from the filament to the plate in the vacuum tube; but in accordance with the old theory, electricity can pass from the plate to the filament but not in the other direction.

(4) To secure the valve effect connection must be made to the **negative side** of the lamp filament and to the plate.

(5) The Fleming valve may be used as a simple **rectifier** for the **detection** of **radio frequency currents** or advantage may be taken of its **non-uniform conductivity** as with the carborundum rectifier. In the latter case, the E.M.F. of a local battery is applied to the space between the plate and filament.

(6) By placing a metallic element called a **grid** between the plate and filament, a wider range of circuits may be employed adapting the tube to a great variety of uses. A tube so constructed is called a "three-electrode" valve.

(7) Such tubes may be connected for **cascade or regenerative amplification.**

CASCADE AMPLIFIERS

(1) The vacuum tube acts as a **repeater of alternating currents** and it will perform that function at frequencies up to several million cycles per second. That is, if an alternating current be impressed upon the grid and film of the three electrode tube, the plate current (supplied by a local battery) will rise and fall at the frequency of the impressed E.M.F. In a properly constructed tube, the current will be repeated with **amplification.**

(2) The **output current** of the tube may in turn be impressed upon the grid and filament of a second tube for further amplification. This process may be continued through several steps. This is called **cascade amplification.**

(3) If radio frequency currents are to be amplified progressively through several steps, **air core radio frequency transformers** are connected between the **output circuit** of one tube and the **input circuit** of the next tube. For the amplification of audio frequency currents **iron core transformers** are connected between successive steps.

(4) If the plate circuit of the tube is coupled inductively, conductively or electrostatically to the grid circuit, **regenerative amplification** results; that is, part of the energy released in the plate circuit is **fed back** to the grid circuit to amplify incoming radio signals. Circuits of this type were first disclosed by Capt. Armstrong. They are termed **regenerative circuits** and may be used for the **self-amplification** of audio or radio frequency currents. Such circuits are often termed **"feed back"** circuits.

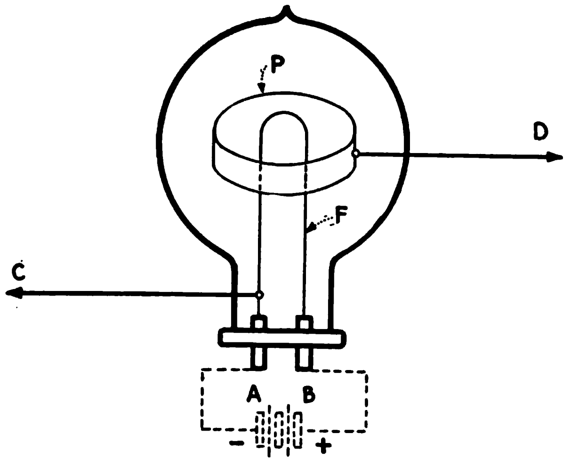


Figure 167—Simplified sketch of Fleming's oscillation valve. A lamp filament F and a metallic plate P are sealed in a highly exhausted tube. The filament is brought to incandescence by a 4 to 12 volt battery. To secure the valve effect, connection is made to the terminals C, D. The tube acts as a rectifier of alternating currents at frequencies up to millions of cycles per second

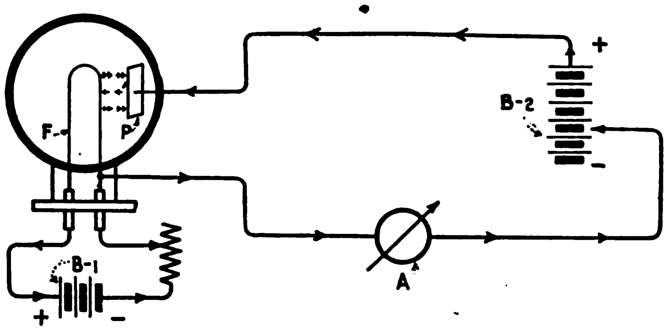


Figure 168

OBJECT OF THE DIAGRAM

To indicate the connections of the apparatus for demonstrating the rectifying properties of the Fleming valve.

PRINCIPLE

An electrical current can pass from the plate to the filament in the vacuum valve, but it is opposed in the opposite direction.

DESCRIPTION OF THE DRAWING

The negative side of the filament F and the plate P are connected to the negative and positive poles of a high voltage battery B-2 respectively. Filament F is rendered incandescent by a battery B-1. A milliammeter is connected in series with B-2.

OPERATION

When plate P is connected to the positive pole of B-2, the meter A will indicate the passage of current through the valve (from P to F), but if the negative pole of B-2 is connected to the plate the meter will not register.

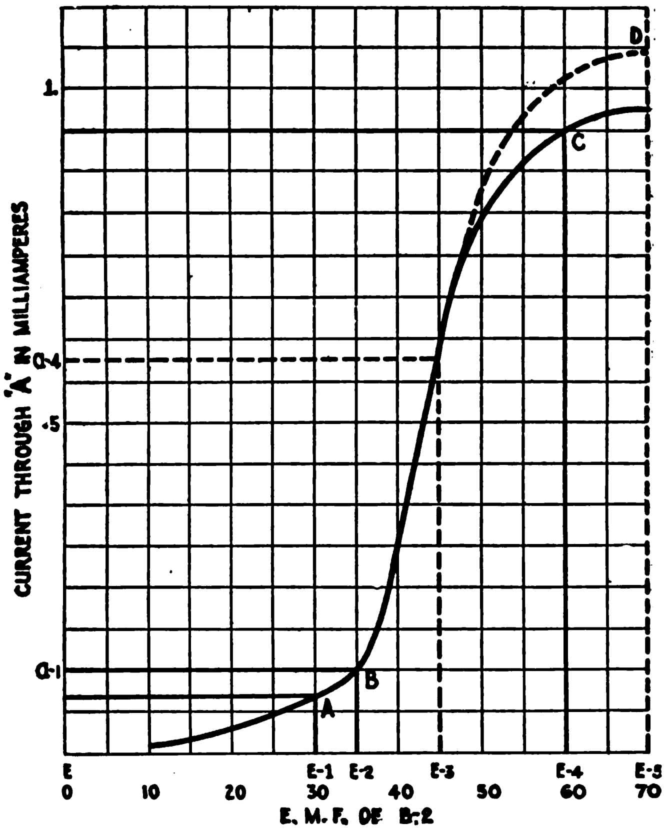


Figure 169—Characteristic curve of the two-electrode tube. This curve shows the relation between the plate current and the E.M.F. of the battery B-2. The curve indicates that the conductivity of the valve is not a constant, but that it varies with the current flowing. At point B a slight increase in the local E.M.F. causes a very great increase of the plate current, but at point C the current begins to fall off. This is called the point of saturation. As an oscillation detector the valve is generally more sensitive, that is, it will give greater response in a telephone, from a radio frequency signal when the local potential is adjusted to correspond to points B or C. What amounts to a rectified current will then pass through the receiving telephone. With some valves other points on the characteristic curve give good response in the telephone

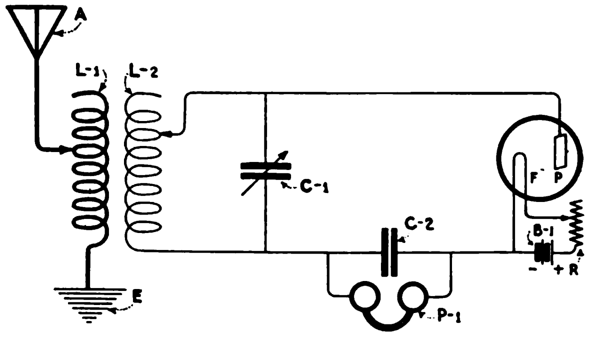


Figure 170

OBJECT OF THE DIAGRAM

To show the use of the two-electrode Fleming valve as a simple rectifier.

DESCRIPTION OF THE DRAWING

The primary coil of a receiving transformer is indicated at L-1 and the secondary coil at L-2. The usual secondary condenser is shown at C-1, the telephone condenser at C-2, and the telephones at P-1. The valve contains the filament F and the plate P. Filament F is fed by the battery B-1 and the incandescence of the filament is regulated on the rheostat R.

OPERATION

When the receiving transformer is tuned to a distant transmitter, an E.M.F. at a radio frequency is impressed between the plate P and the filament F. When P is charged to a positive potential, electricity can pass from P to F, but when P is charged to a negative potential, no electrons are drawn over to the plate, and consequently no current passes the valve. The telephone condenser C-2, therefore receives a uni-directional charge over the duration of a wave train, and at the termination thereof discharges through telephone P-1. Groups of radio frequency currents are thus converted to uni-directional pulses which actuate the telephone diaphragm.

SPECIAL REMARKS

To obtain the correct operating adjustment of the tube, the operator regulates the incandescence of the filament F by means of the rheostat R until the loudest signals are obtained.

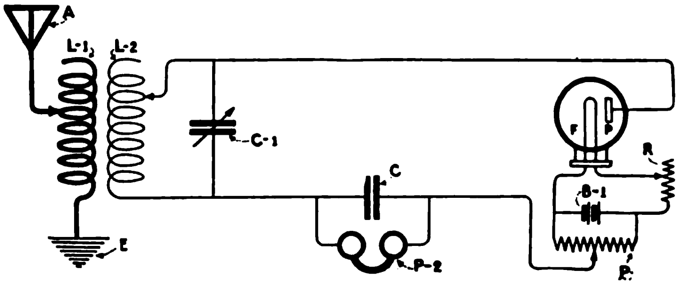


Figure 171

OBJECT OF THE DIAGRAM

To disclose the circuits for the Fleming oscillation valve, in which advantage is taken of the non-uniform conductivity of the tube.

DESCRIPTION OF THE DRAWING

The radio frequency elements of the receiving tuner are indicated by the usual notations. Battery B-1 is shunted by a potentiometer P-1 through which the plate P may be charged to a positive potential. If the sliding contact on P-1 is moved to the right, P is charged positively, but if moved to the extreme left the potential of P in respect to F is reduced to zero. That is, in the former case current flows from the positive pole of the battery B-1 through P-2 through L-2, from the plate P to the filament F, back to the negative pole of the battery.

OPERATION

The best operating adjustment is secured by sliding the variable contact along P-1 until the loudest signals are heard in the telephone.

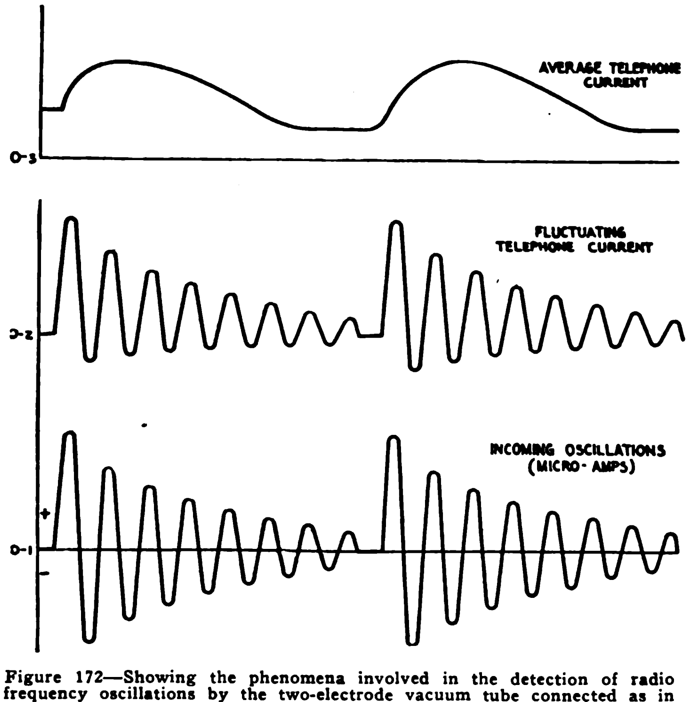


Figure 172—Showing the phenomena involved in the detection of radio frequency oscillations by the two-electrode vacuum tube connected as in figure 171. Graph 0-1 indicates the incoming radio frequency oscillations; graph 0-2, the fluctuating telephone current, and graph 0-3, the average effect of the current supplied to the telephone. This is the effect obtained on the lower bend of the characteristic curve shown in figure 169. At the upper bend of the curve the incoming signals will cause a large decrease in the telephone current. The effect on the telephone in either case is the same.

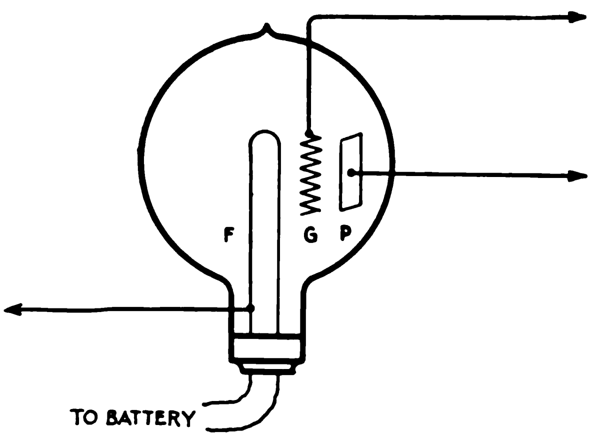


Figure 173—Simplified sketch of the three-electrode vacuum tube, often called the electron relay. The glass envelop contains the filament F, the grid element G, and the plate P. In certain types of tubes, the filament, plate and grid are made of tungsten. Other metals, however, are often employed. One popular type of tube contains a platinum filament, a tungsten grid and a nickel plate.

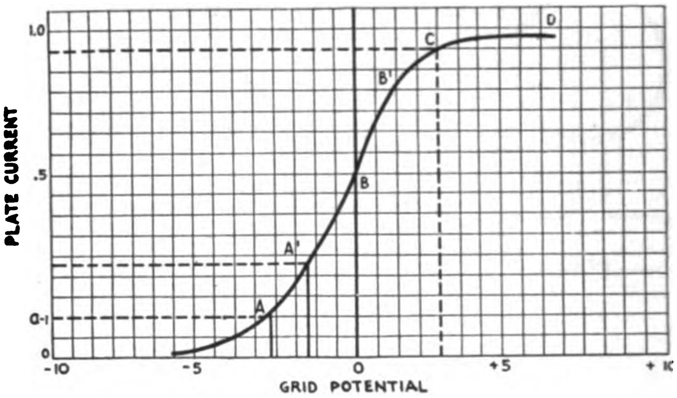


Figure 174—Showing one characteristic curve of the three-electrode vacuum tube. The horizontal axis indicates the potential of the grid in respect to the filament, and the vertical axis the current flowing through the plate circuit. This particular curve indicates that when the potential from grid to the filament is approximately zero, the plate current is 0.5 milliampere. On the other hand, with the grid potential at 5 volts negative, the current in the plate circuit is practically zero. The point of saturation occurs in the region of C; in other words, the maximum plate current flows when the potential of the grid in respect to the filament is about 3½ volts positive.

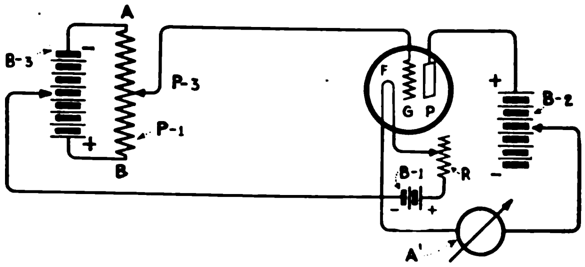


Figure 175—Connections of the apparatus for obtaining the grid-potential, plate-current characteristic of the three-electrode tube. A variable E.M.F. supplied by the battery B-3 is impressed upon the grid G, and the filament F. A battery B-2 supplies current for the plate circuit, the path of the plate current being from the positive side of B-2, from the plate P to the filament F, back to the negative terminal of B-2. A low-range milliammeter A' is connected in series with the plate circuit. By sliding the contact of the potentiometer P-3 towards A, the grid G will be charged negatively in respect to the filament; but by moving the contact in the opposite direction, the grid G will be charged positively. The strength of the plate current under different values of E.M.F. applied to the grid circuit, is shown in figure 174.

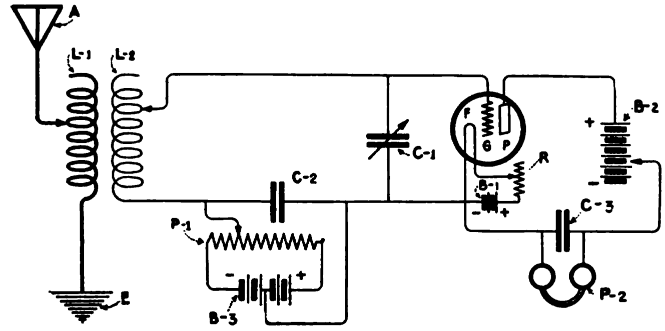


Figure 176

OBJECT OF THE DIAGRAM

To show the fundamental construction and one circuit for use of the three-electrode vacuum tube as an oscillation detector in radio telegraphy.

PRINCIPLE

A metallic element called a grid inserted between the filament and the plate of the vacuum tube may be employed to control the strength of the plate current.

If the grid is charged positively by an external E.M.F., the plate current is increased, but if charged negatively, the plate current is decreased.

Any variable E.M.F. impressed upon the grid circuit will be repeated in the plate circuit with amplification.

DESCRIPTION OF THE DRAWING

The tube contains the filament F, the grid G, and the plate P. The plate current is supplied by the battery B-2 and the filament current by the battery B-1.

The grid G and the negative side of the filament F are connected to the secondary terminals of the receiving transformer.

In order to control definitely the voltage of the grid G in respect to the filament F, a grid battery B-2 shunted by potentiometer P-1 is included in the grid circuit.

OPERATION

To obtain the best adjustment of the vacuum tube the operator regulates the incandescence of the filament by the rheostat R and adjusts the voltage of the battery B-2 until, for example, the loudest signals are obtained in the telephone P-2 from a test buzzer in inductive relation to some part of the receiver circuit.

During the reception of the signals, the sliding contact on the potentiometer P-1 is moved back and forth until the loudest signals are obtained. In some tube receiver sets the incandescence of the filament is regulated by an ammeter connected in series, but if the ammeter is not supplied the correct adjustment is obtained by test.

SPECIAL REMARKS

(1) When the operator adjusts the circuit of figure 176 for the maximum strength of signals, he works the tube at either point A or point B on the characteristic curve of figure 174.

(2) When the receiving transformer is tuned to the distant transmitter, an alternating E.M.F. is impressed between the grid G and the filament F. If the potential of the grid in respect to the filament F is adjusted by the battery B-3 to point A on the characteristic curve, the negative half of the incoming cycle will reduce the plate current and the positive half will increase it. But as the curve indicates the increase will exceed the decrease and therefore what amounts to a rectified current will flow in the plate circuit which charges the condenser C-3. Condenser C-3 then probably discharges in one direction through the head telephone P-2.

(3) It is clear from the curve that if the potential of the grid in respect to the filament is regulated to point C, then the negative half of the incoming oscillation will cause a large decrease in the plate current and the positive half a slight increase. In either way the telephone diaphragm will be impulsed once for each group of incoming oscillations.

(4) It is clear from the curve of figure 174 that if the potential of the grid in respect to the filament lies along the region from A-1 to B-1 and a radio frequency current is impressed upon the grid circuit, it will be repeated in the plate circuit substantially without distortion; that is to say the increases and the decreases of the plate current will be equal. But at other points along the curve, the plate current will either increase to a greater extent than it decreases, or vice versa, with the result that the telephone P-2 is traversed by uni-directional currents.

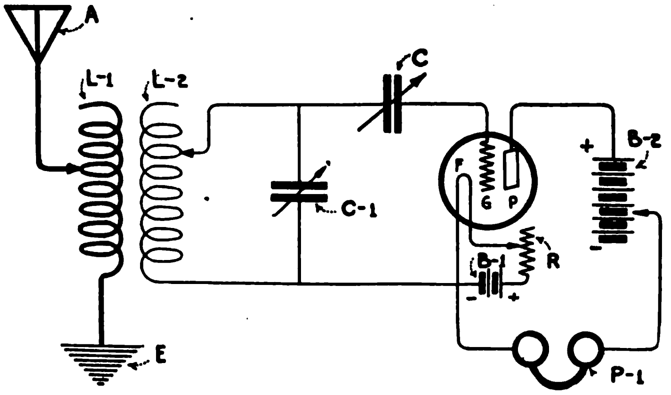


Figure 177

OBJECT OF THE DIAGRAM

To show the circuits of a three-electrode vacuum tube as an oscillation detector, employing a grid condenser.

PRINCIPLE

By connecting a condenser in series with the grid, incoming radio frequency oscillations are rectified and a charge accumulates in the condenser which leaks out at the termination of each wave train. The alternate increase and decrease of the grid potential by this action causes the plate current to vary at the spark frequency of the transmitter.

DESCRIPTION OF THE DRAWING

The receiving transformer is indicated by the usual radio frequency tuning elements, and there is included in series with the grid, a grid condenser C. As usual current from B-2 flows from the plate P to the filament F through the head telephone F-1 to the negative side of the battery.

OPERATION

When the receiving transformer is tuned to the distant transmitter, alternating currents are impressed between the grid G and the filament F. By the usual valve action these currents are rectified between G and F and a uni-directional charge is stored up in the condenser C which is negative on the grid side. As is clear from the characteristic curve, this reduces the plate current, but at the termination of a group of incoming oscillations, the charge leaks out the condenser C through the valve, or through a special leak resistance. The plate current then returns to normal value. This reduction and subsequent increase of the current follows the spark of the transmitter.

As in the circuit of figure 176, the radio frequency currents flowing in the grid circuit are repeated in the plate circuit, but these currents are not heard in the head telephone. They are put to account, however, in the regenerative circuits to be described further on.

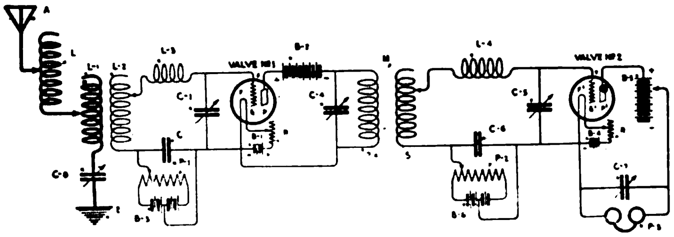


Figure 178

OBJECT OF THE DIAGRAM

To show the connections of vacuum tubes for cascade amplification at radio frequencies.

DESCRIPTION OF THE DRAWING

The plate circuit of valve No. 1 and the grid circuit of valve No. 2 are coupled through a radio frequency transformer M having the primary windings P-4 and the secondary windings S. The grid circuit of valve No. 1 includes the grid battery B-1 and the potentiometer P-1; similarly the grid circuit of valve No. 2 has a grid battery B-6 and a potentiometer P-2.

The antenna, grid and plate circuits of the first valve and the grid circuit of the second valve are tuned to the frequency of the incoming signals.

OPERATION

Assuming the voltages of batteries B-2 and B-5 to be properly adjusted, and the filament temperature of F and F-1 to be regulated by their rheostats, the operator adjusts the potential of the grid to filament of the first valve by means of potentiometer P-1 so that the incoming radio frequency currents are repeated in the plate circuit P-4, C-4 with amplification. The radio frequency current repeated into the plate circuit is impressed upon the grid circuit of the second valve through transformer M, the grid circuit being tuned to the frequency of the signal by the secondary inductances S, the loading inductance L-4, the variable condenser C-5 and the fixed condenser C-6.

The potential of the grid in respect to the filament of the second valve is adjusted by potentiometer P-2 so that the radio frequency current impressed upon the grid circuit is repeated in the plate circuit with distortion; that is, the grid potential is adjusted so that the repeated plate current in the second valve increases to a greater extent than it decreases or vice versa. Then what amounts to a rectified current flows through the head telephone P-5.

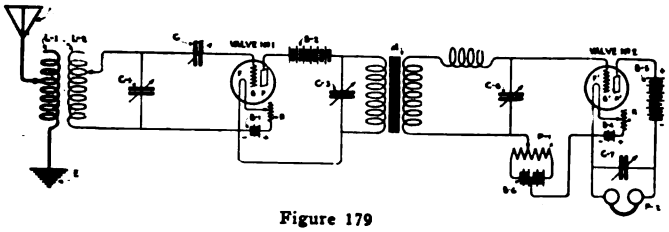


Figure 179

OBJECT OF THE DIAGRAM

To show the circuits of a cascade audio frequency amplifier.

DESCRIPTION OF THE DRAWING

The plate circuit and the grid circuit of the tubes are coupled through an iron core transformer M. A grid condenser C is inserted in the circuit of the first valve to secure an audio frequency relaying effect upon the plate current. The audio frequency current in the plate circuit is impressed upon the grid circuit of a second valve through the iron core transformer M. This circuit includes the battery B-6 and potentiometer P-1 through which the operator adjusts the potential of the grid in respect to the filament to secure the maximum strength of signals in the head telephone.

OPERATION

The capacity of condenser C, the temperature of the filament and the voltage of battery B-2 are adjusted until the maximum possible variation of current is obtained in the plate circuit of B-2 as may be determined by connecting a head telephone in that circuit. The primary and secondary windings of the transformer M are closely coupled. These circuits may be tuned to the desired audio frequency by shunting the primary coil with the condenser C-3 and the secondary coil with condenser C-6. By careful adjustment of the potentiometer P-1 and by variation of the capacity of the condenser C-7 the maximum strength of signals will be obtained.

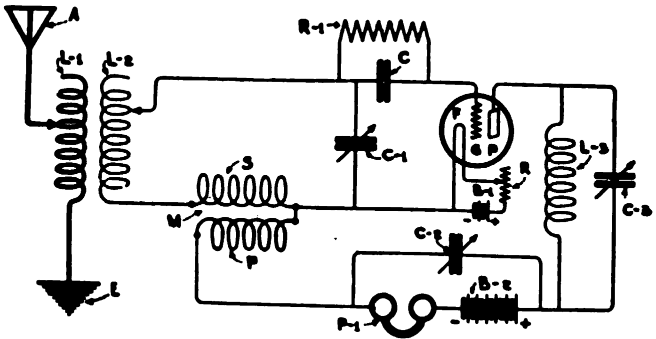


Figure 180

OBJECT OF THE DIAGRAM

To show the complete circuits of Armstrong's regenerative receiver for the amplification of audio or radio frequency currents.

PRINCIPLE

By coupling the plate circuit of a vacuum tube to the grid circuit, either through an iron core or an air core radio frequency transformer, part of the energy liberated in the plate circuit can be fed back to the grid circuit for increased amplification.

DESCRIPTION OF THE DRAWING

The primary winding of the receiving transformer is indicated by L-1, the secondary by L-2 and the plate and grid circuits are coupled through the transformer P, S. The usual shunt secondary condenser is indicated at C-1 and a grid condenser at C. In the case of highly exhausted vacuum tubes condenser C is shunted by a leak resistance of several hundred thousand ohms.

The plate circuit is tuned by the inductance L-3 and the shunt condenser C-3. In order to by-pass the radio frequency current around the head telephone P-1 a condenser C-2 is shunted across the battery and the telephone.

OPERATION

The receiving transformer is tuned to the distant transmitter in the usual way. The correct operating adjustment of the vacuum tube having been obtained, and resonance having been established with the transmitter, the coupling between the coils P and S is carefully varied until the maximum strength of signals is secured.

This coupling must be carefully regulated so as to amplify the incoming signals only, for otherwise the complete circuits of the tube will be set into oscillation at a radio frequency and it will then become a beat receiver.

SPECIAL REMARKS

(1) The production of beat currents is evidenced by the fact that the normal spark note of the spark transmitter is lowered in pitch, but by careful adjustment of the coupling between P and S these signals can be amplified without the production of beats.

(2) If the audio frequency current in the plate circuit is to be amplified, the windings P and S may have an iron core. The inductance of P and S may then amount to several henries each.

The Future Wartime Wireless Series

Part II of this Wartime Wireless Instruction will begin in the November issue. It will deal with undamped wave transmitters and vacuum tube receivers for the reception of continuous oscillations. The direction finder and other special appliances will be treated fundamentally. A discussion of the basic principles of wireless telephony will terminate the series.

Where There's A Will

How Men Were Prepared for Wireless Duties to Meet the Nation's Emergency—Some High Lights on the Cincinnati Effort

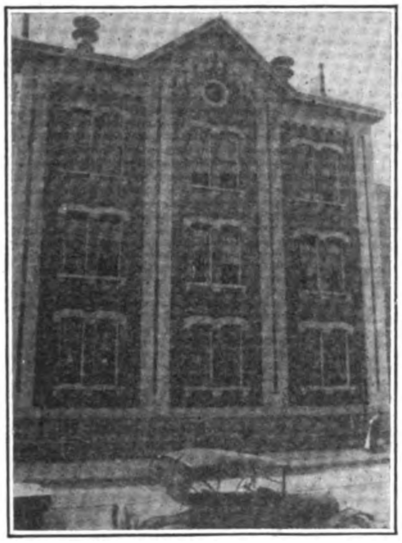
By Maurice Henle

"SMILING BILL" Frankenstein is somewhere on the ocean, headed eastward. On his collar is the insignia of the Signal Corps, and in his fertile brain a wealth of dots and dashes which will be turned to Uncle Sam's advantage against the Hun on France's soil.

"Smiling Bill" couldn't and wouldn't stay out of the service. Nature, however, had gambled heavily with his chances, and apparently was winning. At any rate she was smiling broadly. "Bill" was way underweight.

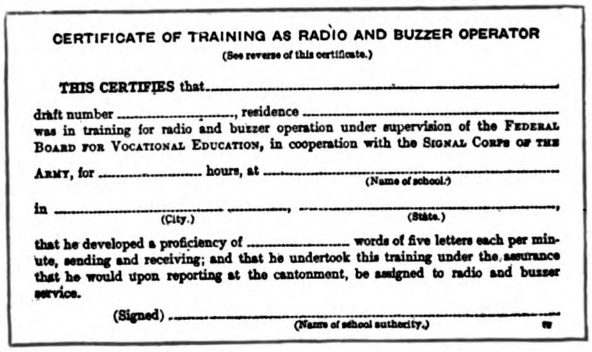
He had his eye on the navy, and some months ago steered for the recruiting station. No luck. He interviewed the army physical examiners, with an equal amount of misfortune. He grew very depressed.

As luck would have it, he happened one day to meet H. Serkowich, an instructor at the Cincinnati Continuation School of Radio Telegraphy, and also connected with the Cincinnati Chamber of Commerce; he told the instructor of his unsuccessful attempts at getting into the service.



Left—Cincinnati Continuation School, where radio classes are held

Right—Charles H. Elston, assistant prosecutor, Hamilton County, who heard the call of radio and is now an army aviator



Below—Certificate of training issued to men called in the draft

CERTIFICATE OF TRAINING AS RADIO AND BUZZER OPERATOR

(See reverse of this certificate.)

THIS CERTIFIES that..............................

draft number.................., residence..............................
was in training for radio and buzzer operation under supervision of the Federal Board for Vocational Education, in cooperation with the Signal Corps of the Army, for.................. hours, at..............................
(Name of school.)

in.............................., ...,
(City.) (State.)

that he developed a proficiency of.................. words of five letters each per minute, sending and receiving; and that he undertook this training under the assurance that he would upon reporting at the cantonment, be assigned to radio and buzzer service.

(Signed)..............................
(Name of school authority.)

"Come to the Radio School, and fit yourself for the radio service," Serkowich advised, "it will fit you for a place in the Signal Corps."

"But I'd have to pass a physical examination to get into the army, and they have turned me down once," Frankenstein said.

"Never mind that," Serkowich reassured him, "you leave getting into the service to me."

So Bill enrolled at the radio school, which is operated under the auspices of the United States Government and the Cincinnati Board of Education, preparatory to taking his place in the ranks of the Signal Corps. Everything went smoothly; he sailed through the course like a clipper ship through water.

Soon the day came when he was to apply with his certificate of proficiency at the army recruiting office. He approached Serkowich.

"Well," he said, "tomorrow I try to get into the army. I am still thirteen pounds under weight."

"Follow my instructions and before tomorrow night you will be in the army," Serkowich told him.

"Bill" gulped when he heard the instructions.

"Buy a dozen large bananas," Serkowich said evenly, "eat them slowly, and between each, drink a full cup of water. You can do it."

A few days later "Bill" again sought Serkowich.

"Well," he said, smiling, "I leave tonight for a port of embarkation. I had hardly arrived at camp when they asked for volunteers for immediate service overseas. I'm happy—but say, listen—I will never again be able to look a banana in the eye!"

Just before sailing, and after a few weeks in an eastern camp, "Bill" wrote back to Serkowich, telling him that he was now legitimately up to the required weight, thanks to the outdoor life.

Shortly after April 6, 1917, when President Wilson spoke the words which were to start the mobilization of a mighty nation's resources, men, money and ships were seen to be the great needs. Millions of each had to be obtained.

The war was 4,000 miles away and miles of water separated Verdun from New York. We had to have ships to take the men and food to France. The cry for ships grew. "We must have ships, ships, and yet more ships!" and the Emergency Fleet Corporation sprang into existence. Men were needed to man the vessels. Wireless operators were needed aboard. "Give us ten thousand radio operators; for the navy, for the land army, and for aviation!"

And it was to help supply this need that the Cincinnati Continuation School for Radio Operators began.

The Federal Board for Vocational Education broadcasted a general appeal to all school boards, asking their co-operation in supplying operators, requesting that the facilities of the school buildings be placed as much as possible at the disposal of the Government.

Cincinnati had the advantage of other cities, in that a somewhat similar work had already been started at the Continuation School, operated by the Cincinnati Board of Education. Telegraph messengers, below the age limit required by law, had to come to the school part of the working day. A course in Morse telegraphy was offered, along with other studies, so that the boys received a fairly practical education.

It was comparatively easy for Superintendent of Schools Randall J. Condon, a famed educator, to broaden the scope of the school.

Miss Mary Conway, the principal of the Continuation School, was a woman with wide experience. With years of practical training behind her, Miss Conway plunged into the new work with vim and vigor. She recognized that without practical surroundings for the students, progress would be necessarily slow. So she acquired a full set of equipment, including typewriters, keys and instruments and transformed the room into a real "Western Union" school.

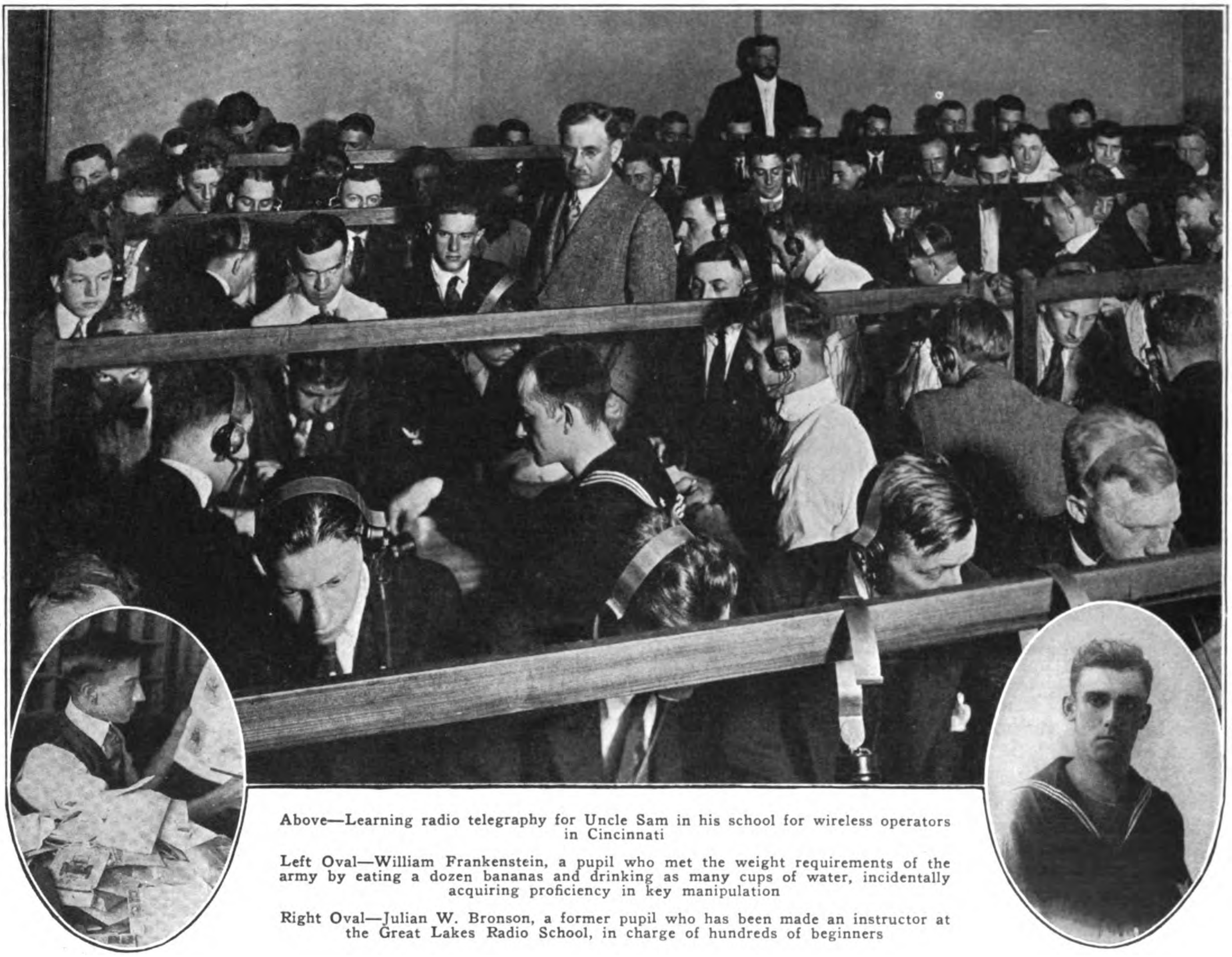
Progress was rapid and many a young man and woman, as well as older men, obtained a position at the key with the great commercial telegraph companies.

It was at this time that the Ohio National Guard was encamped at Sharonville, Ohio, preparatory to going to Camp Sheridan, Ala. The Signal Corps of the army was in its youth; but the experience of our allies taught us many things which we were not required to have rammed down our throats, and the War Department soon started out in an efficient way to bring the Signal Corps up to a high standard. Major Dube of the Ohio militia, who seemed to have a greater pre-vision than a good many, heard of the good work accomplished at the Continuation School and of the wonderful benefits the telegraph companies were reaping, and brought sixteen of his non-commissioned officers to the school to learn the code.

They were only there a few days when it was seen that there was not a competent instructor to teach the men what they really should have learned—the Continental Code for radio work. Major Dube cast about for a man. He finally decided upon H. Serkowich, with the Cincinnati Chamber of Commerce, a man with wide experience both as a radio and telegraph operator and a wire chief on steamships and railroads.

Serkowich, however, couldn't leave his work at the Chamber of Commerce, nor could he sacrifice the indirect work he was then doing for the Government. He agreed, however, to give his services if the classes would be conducted at night. Miss Conway and Superintendent Condon consented to the change gladly, and the twilight school was started.

Serkowich immediately shifted to the Continental Code and it was not very long before those sixteen "non-coms" and sixteen more had qualified with flying colors, competent to take over the army signalman's job.



Above—Learning radio telegraphy for Uncle Sam in his school for wireless operators in Cincinnati

Left Oval—William Frankenstein, a pupil who met the weight requirements of the army by eating a dozen bananas and drinking as many cups of water, incidentally acquiring proficiency in key manipulation

Right Oval—Julian W. Bronson, a former pupil who has been made an instructor at the Great Lakes Radio School, in charge of hundreds of beginners

In seeking another competent instructor, the Board of Education plucked Frederick W. Dearness, principal of the 12th District School, who was well versed in wireless telegraphy.

Serkowich recently has been commissioned a lieutenant in the navy. He was assigned to the Cincinnati district and is still at the school.

Equipment had been supplied by public-spirited men and women. This equipment, moreover, was complete. The desks, designed by Serkowich to accommodate the maximum number, were installed by the school board carpenters. Buzzer systems and head pieces were given by the telephone company and a local electric company. In the Morse Section, the typewriters were bought by the Board of Education, as was the other equipment.

About this time the draft became active. The National Army, in its process of formation, needed signal men badly. This dearth of men prompted Colonel L. D. Wildman, U. S. A., of the Signal Corps, stationed at Chicago, to write to the Cincinnati school authorities, appealing to them to help the Government in this crisis.

"In the organization of signal troops," he wrote, "a grave difficulty has been discovered in securing the required number of Morse and radio telegraphers for the first increment of troops. Since it has been found difficult to secure the required telegraphers for the first increment, it is an assured fact that unless immediate steps be taken to increase the number of available telegraphers the situation will be even more serious for further increases of the army. It is, therefore, most important that efforts be devoted to educating students in sending and receiving by the Morse and Continental codes with proficiency."

Wide publicity brought many students, most of whom were of the draft age. One room broadened to two, and two to five.

* * * *

One hundred and fifteen men have received certificates of efficiency from the school and have been recommended to the Federal Board for Vocational Education, at Washington, with which the school is affiliated.

Of the one hundred and fifteen, sixty-two are in the navy, twenty-six in the air service, or Aviation Section, Signal Corps, and twenty-seven in the land army. Many joined the service without receiving their certificates and made good. Enrolments have totaled hundreds. Of the navy's sixty-two, many have gone through Harvard University, and are at this moment on the ocean.

Memorizing the Continental Code is the first step at the school. Recruits are taught to make signals on the telegraph key and to transmit sentences. Practice in code sending and receiving comes next. Then they learn to speed up and to combine speed with accuracy. At each step they are moved up in the school. When they are in the fifth "stage," recruiting officers from the army, navy, and air service give them talks, each pointing out the merits of his particular service.

* * * *

The call of wireless penetrated deep. It spread its enticing fingers into all walks of life. Charles H. Elston, assistant Hamilton county prosecutor, was one of those who heard it and answered in the affirmative.

He is now at the Ohio State University at Columbus putting the finishing touches to his course, from which he will soon emerge a pilot in army aviation.

Elston didn't have to go; he had been placed in Class 3 of the draft. However, he went to the radio school, and was recommended for the Signal Corps. According to letters received by his mother, he attributes the major portion of his rapid progress through the training school to the course at the Cincinnati school.

Julian W. Bronson is another who made good. Because of the training he had received at the Cincinnati school, Bronson was made an instructor at the Great Lakes Radio School and placed in charge of hundreds of beginners. He received his certificate of efficiency November 15, 1917, together with Willard B. George, Matthew Schenchoff and Edward J. Corcoran, the first of the civilians to complete the course.

All four served as instructors for some time; then Bronson, with two others, grew restive for active service, and insisted they be sent to Harvard so as to qualify for service by summer. He completed his course at the University and is at this moment at an eastern port ready to take his place beside the key with an invincible fleet or on our fast growing merchant marine.

"The school at Cincinnati has been a wonderful help," he wrote his father, who is attached to the Cincinnati Post Office Inspector's office.

Millionaires were no exceptions when the multitudes of red-blooded youths thronged to the service. Shoulder to shoulder at the school with sons of ice wagon drivers and bakers, for six weeks, was Cornelius J. Hauck, son of Louis Hauck, millionaire Cincinnati brewer. Young Hauck—he is 23—is about to graduate from a field in Tennessee as a bomber in aviation. He writes that the knowledge he received in Cincinnati helped him marvelously.

* * * *

And so the wheels of learning have ground; minds have been moulded and careers shaped with each daily revolution.

The old building has recently been painted. But the paint is only a weak, outward manifestation of the remarkable change on the inside.

The halls still brouse in semi-darkness, a reminder of the days of disuse before the war, but the rooms are a living, quivering example of bustle and life. Here is a tailor, worth $200,000 in his own name, vainly trying to catch the meaning of the whining jerks of the instrument, operated by a $15-a-week shoe clerk. Shoulder to shoulder they are, a room full. Here is Fred. W. Dearness, a school principal in the daytime, instructing Jim Brown, the cobbler's son, and doing his utmost to knead Brown's brain so Uncle Sam will benefit. The boys' faces, for the most part, are stern, and it doesn't take a super-imagination to transplant them to a ship, or a battlefield, or an airplane.

And as one passes from the busy room, the hums, and slurs, and buzzing notes, charge the air with a vibratory message of conquest to come. The sharp notes of the telegraph key are heard, from other rooms, where girls are learning to take the places of the men who go. And the many typewriters with their clatter almost make the place sound like a business college.

Hustle and hurry—and for what? For Uncle Sam; for you and me; for democracy. The old school, the busy students, everything, all are but a remarkable example of the adaptability of the schools of the land of the Stars and Stripes to meet a crisis—and meet it with vigor!

Torpedoed!

(*Continued from page* 18)

of our sailors and firemen who could not withstand temptation broke into the cargo of dried fruit, for which they were put in irons. Our coal supply was about exhausted and the captain decided to change our course and steer for Bermuda, where we could replenish the bunker.

On January 13th we had another alarm! We sighted what appeared to be a submarine ahead of us, rolling about in the sea. Upon drawing nearer we found it to be a submarine chaser flying distress signals and the flag of France. As we drew alongside, S. C. 171 could be distinguished on her bow. The captain ordered a lifeboat lowered and an officer went aboard the chaser.

There were twenty Frenchmen aboard. They were weak from the want of food. Some of them were so near starvation that they were unable to stand.

From what information we could gather from the officer we learned that they had become separated from their escort in a terrific gale. Their engines were disabled and

(*Continued on page* 43)

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World Wide Wireless

(*Continued from page 9*)

A Job For Retailers in Electrical Supplies

THE big guns at the front are mounted on money. Don't forget that! And they will hold the enemy back only so long as their foundations last. Don't forget that!

This war cannot be carried on on loyal sentiment and armchair strategy. It has got to be carried on with big armies, powerful guns and everything guns and armies need for continued action.

War Savings Stamps will furnish the money provided retailers enlist their salesforce at full power to sell the stamps. Some of them have more salespeople at command than a regimental commander has fighting men. Just think a moment of the selling power of a store as big as that. Just think of the stamps it could sell if it worked only 15 minutes a day. And the smaller stores can do as well in proportion.

Ask your local dealers to put in a Thrift Stamp Department today if they haven't already done so. And then push the stamps!

Enrollment in Radio Sergeants School Open

"SCORES of German machine-gun nests hidden in this wood stopped the advance of our troops, but the American artillery opened so hot and accurate a fire that the majority of them were silenced; the infantry then rushed the others," is often the wording of an official communique from the front in France.

There must be accurate observation, correct transmission of information back to the artillery headquarters, calculation of the range and direction at which to set the guns; and the rest is simple.

Observations far behind the enemy lines are made by airplane. The aerial observer has a wireless sending set, and back near headquarters there is a radio sergeant with a wireless receiving set. As soon as a message is received at headquarters it is telephoned to all batteries firing or about to fire on that target.

Telephone lines connect each battery with its headquarters, and each headquarters with the next higher in the chain of command. These telephone lines have been constructed and are maintained under all difficulties encountered in modern warfare by the electrician sergeants. These electrician sergeants also operate the searchlights used in night operations against hostile aircraft and bodies of troops.

Every time a gun is shifted, its location on the map must be accurately determined by survey and triangulation. It takes a specialist to do it and this specialist is an enlisted man trained as a master gunner.

These radio sergeants, electrician sergeants and master gunners are being trained for this service in a twelve weeks' course at the coast artillery school at Fort Monroe, Va. Hundreds of men are being turned out in every class.

Any civilian, whether he be subject to draft or not, or any enlisted man now in the service, is eligible to enroll for this course of training and attend the coast artillery school, provided he has the proper qualifications, physical and mental.

The physical qualifications are those required of all recruits for general service. The mental qualifications are outlined in a bulletin issued by the coast artillery school, which may be had for the asking. Requests for this information may be made of the director, Department of Enlisted Specialists, Coast Artillery School, Fort Monroe, Va.

Daughter of Morgan's Partner an Inspector

AMONG the first of the wealthy women of America to don overalls and accept manual toil was Miss Alice Davison, daughter of H. P. Davison of J. P. Morgan & Co. and the American Red Cross. For $20 a week Miss Davison works every day as radio inspector in a wireless factory in upper New York.

Miss Davison, who is only twenty, explained that her purpose was to release a man for the front. She is one of a group of young women who took a special course of instruction as radio operators.

Wireless Equipment for Lightships

BRENTON'S Reef lightship, off the south end of the island of Rhode Island, has been equipped with wireless apparatus for the first time as the outcome of the German submarine raid. The announcement of the fact calls attention to the stupid neglect of the past. The loss last winter of Cross Rip lightship and the fact that its crew had no means of radio communication emphasized a lack of liberality and progress in the lighthouse establishment, or perhaps in congressional provisions, and warranted the belief that before this time all of the off-shore light stations would be provided with modern means of calling for assistance or rendering aid to mariners in distress.

If it was necessary for the submarine raider to enforce a lesson that even the loss of the Cross Rip vessel and crew failed to teach, then we owe something to the imperial German navy.

Perhaps some allowance must be made for war conditions in explaining the delay in supplying radio equipment for the lightships, but the war makes the improvement more necessary now than in peace.

Marconi Marine Co. Earns Over Two Million

DURING 1917 the business of the Marconi International Marine Communication Company increased by nearly 100 per cent. in gross revenue, according to the directors' report which has just been issued.

The gross revenue for 1917 amounted to £470,657, an increase over the preceding year of £200,476. This increase was derived principally from rentals of additional ships fitted. However, it is pointed out that necessary restrictions in respect of private messages at sea have continued and prevented revenue being received from this source.

The profit for the year amounts to £192,055, and from this figure is deducted £50,000, being a necessary allowance for obsolescence of plant, leaving a net profit of £142,055. During the preceding year the net profit amounted to £96,748. The improvement is about proportionate to the increase of the business. The balance of the debenture reserve account and the balance of share premium account have been transferred to general reserve, which now amounts to £258,009. The losses sustained in consequence of attacks upon the mercantile fleet during the year 1917 have been debited to profit and loss.

The total number of public telegraph stations owned and worked by the company on the high seas increased from 1,472 at the end of December, 1916, to 2,265 at the end of December, 1917. The organization of the company, together with that of its associated companies, with a total of some 4,000 mercantile vessels fitted with Marconi telegraph stations, has continued to render inestimable service, says the report.

The directors recommend a final dividend of 10 per cent., which, with the interim dividend of 5 per cent. paid in February, will make 15 per cent. for the year. The Amalgamated Wireless (Australasia), Ltd., in which the company is interested, has paid a dividend of 5 per cent. in respect of the year ending June 30, 1917.

Crack Austrian Naval Operators Arrested

AGENTS of the Naval Intelligence Service on August 31st picked up two wireless operators who, it is alleged, came to the United States on the steamship Martha Washington of the Austro-American Line, which sailed from Trieste on July 18, 1914, and took them to the New York Port Alien Enemy Bureau, where the men were questioned by Chief Examiner Perry M. Armstrong.

The men are George Fergal, a warrant officer in the Austrian navy, born at Klagenfurt in 1893, and Guido Gassa, born in Vienna in 1886, who enlisted in the Austrian navy when 16 years old, but claims to have received his discharge in 1909.

They were taken into custody when it was discovered, it is alleged, that they are still receiving pay from the Austrian Government and that both are well acquainted with the confidential code of that Government.

Fergal has three brothers now in the Austrian army and one brother has been killed in the present war. He enlisted in the Austrian navy in 1911 and became a wireless operator, serving on various ships of the navy. He was then put on duty handling the confidential code of the Government at a land station.

In July, 1914, after war was declared, he was assigned, it is alleged, to the Martha Washington by the "Funken Telegraf Inspectory." Papers in his possession indicate that he belongs to the "Imperial and Royal Wireless Department of the Austrian Navy."

Gassa, who is said to be the best wireless operator in Austria, speaks six languages—German, Slav, Italian, Bohemian, Spanish and English. He was assigned to various naval vessels. His claim is that he got his discharge from the navy in 1909, but this is doubted by the Federal officials. He, too, it is said, was assigned to the Martha Washington by the Funken Telegraf Inspectory.

The Martha Washington, which reached here on August 2, 1914, was interned. The operators remained aboard the steamer at Staten Island until it was taken over by the United States.

Since April 24, 1917, it is alleged, the Austrian Government has been paying the two wireless operators through the Transatlantic Trust Company, which was taken over by the Alien Property Custodian a few weeks ago. Gassa has been receiving $70 a month and Fergal has been paid $55 a month it is said.

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Navy's News a Daily Radio Feature

EACH night the Navy Department sends out from Washington a wireless news service, "The Navy Press," to all ships and coast radio stations. The message ranges from 800 to 1,600 words in length and contains items of general and particular interest to officers and seamen in every branch of the naval service. Each day the budget of news is carefully sorted and the more important events are put into concise English. During the night the words are flashed out by the Government's radio operators, and next morning there appears upon the ship's bulletin boards a résumé of all the previous day's happenings, both abroad and at home.

No cipher is used and the process is known as "broadcasting." It goes out to any and every vessel, battleship or merchantman, whose radio instrument is tuned to receive it.

On small ships one bulletin board is usually enough to contain the news for those aboard. On a large man-of-war there may be ten or even more. One is ordinarily placed in the ward room, one in the junior officers' mess room, one in the warrant officers' mess room, and one in the chief petty officers' mess room. Several bulletin boards for the crew are located in convenient gathering places about the ship. Besides the bulletin boards, a copy of the news letter is given to the ship's commander and, if there chances to be an admiral on board, a special copy is prepared for him also.

The news needs of men aboard a battleship are as various as their tastes and dispositions. All are interested in war developments, but each seaman also has his particular hobby. One is eager to know what is happening in the theatrical world, another is chiefly concerned with the fluctuations of the stock market. The United States Navy Press Service recognizes this divergence of interests and caters to the different wants.

Closely related to the interest in market reports is the desire of the sailors to know about the financial standing of Government bonds. A great many of them own Liberty bonds. Although they feel sure of the security of their investment they like occasionally to be reassured.

Baseball, the national sport, is constantly in the minds of the boys at sea. Although they are unable to play while cruising (for the deck of a ship is a poor place to knock flies and swat out three-baggers), they flock eagerly to the bulletin boards to read notices of the games of the landlubbers. When the big-league season opens, reports of all the important games become a regular feature of the service. When a world's series is on, or a decisive game is to be played near the end of the season by closely matched teams, special wireless messages are sent out for the information of the jack-tars.

Contemporary Editor Taltavall Dies

THOMAS R. TALTAVALL, aged sixty-three years, editor of Telegraph and Telephone Age, New York, died at his home at Mahwah, N. J., on September 2nd of heart disease, after an illness of several months.

Mr. Taltavall learned telegraphy at Wellsville, Ohio, in 1867 and soon developed into one of the most expert telegraphers in the country, being employed in many of the larger offices. He was selected as one of the original operators to man the first wire leased by the Associated Press to carry the newspaper service between New York and Washington in 1875, and was assigned to the Washington, D. C., Bureau. He was soon after transferred to the New York office, with which he remained fourteen years, in the latter eight filling the position of superintendent of the leased wire system of the Associated Press. In 1890 he resigned to become editor of the Electrical Age. In 1894 he became associate editor of the Electrical World, which position he held until 1911, when he accepted the editorship of Telegraph and Telephone Age. Mr. Taltavall was the inventor of many useful electrical devices and was one of the best-known writers of electrical literature in the country.

Chinese To Have Wireless Telephones

THE Chinese Government has made an agreement with the English Marconi Company to purchase wireless telephones at a price of £300,000. The telephones are to be delivered within nine months. The price will be deducted from a loan of £600,000 at 8 per cent.

The Government has received advances which make possible a resumption of the fighting against the South, which recent events had rendered doubtful.

Finding Your Way Across the Sea

The instruction series by Capt. Uttmark which has been running in The Wireless Age has been interrupted by the pressure of work on the author, who is engaged in training men for the Government. The suspension of this feature for an indefinite period is therefore regretfully announced.

The Editor.

Progress In Radio Science

(*Continued from page* 14)

and one anode. Each cathode is connected to the negative terminal of a high voltage source of direct current through a large inductance and a resistance; and the anode, likewise through an inductance to the positive terminal. An oscillatory circuit is shunted between the cathodes.

In figure 1 the arc generator is furnished with direct current, but in figure 2 it performs the combined function of rectification and generation being fed by an alternating current dynamo.

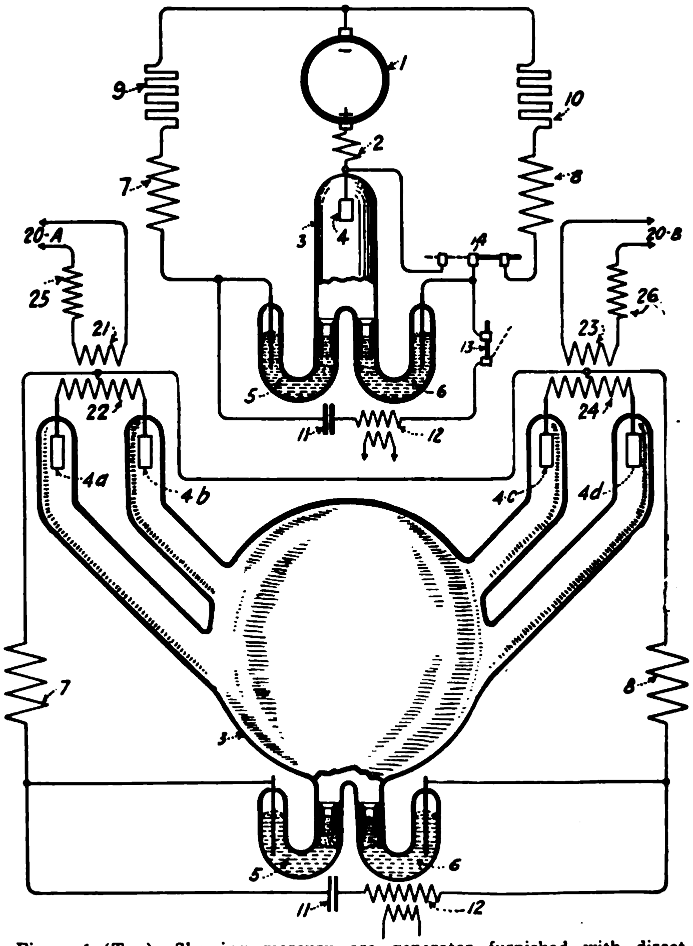

Figure 1 (Top)—Showing mercury arc generator furnished with direct current
Figure 2 (Bottom)—Mercury arc generator fed by an alternating current performing combined function of rectification and generation

Referring to figure 1 a source of high voltage direct current such as a high voltage dynamo, is shown at 1, with plus and minus terminals as indicated. To prevent high frequency energy from getting back into the supply circuits, an inductance is provided such as is shown at 2, although any other suitable means may be employed for this purpose. 3 designates a mercury vapor tube having an anode 4, and two mercury cathodes, 5 and 6. Cathode 5 is connected to the negative terminal of 1 through a large inductance 7 and a resistance 9, and cathode 6 is likewise connected through the inductance 8 and resistance 10. Since these cathodes alternately carry the main current through the tube, they may be called "arcing cathodes." Inductance 7 and resistance 9 may be conveniently combined into a single coil having proper inductance and resistance. Likewise 8 and 10. Inductances 2, 7 and 8 should preferably be wound so as to have a minimum distributed capacity. An oscillatory circuit, comprising, for example, a condenser 11 and inductance 12, is connected between the cathodes as shown. The tube may be started in a variety of ways. The method shown here is as follows: A switch 13 in the oscillatory circuit is opened, and a double throw switch 14 is thrown to the left. These positions are shown by the dotted lines in the figure. The cathode 6 is thus temporarily made a starting anode, and by tilting the tube in the usual manner, the discharge through cathode 5 is started and will be maintained. Switch 14 is now thrown to the right, the position shown in the drawing by the full lines, and if the tube is again tilted, cathode 6 will be started. Two such parallel discharges are ordinarily highly unstable, but if each cathode is supplied through a suitable induct-

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ance, as shown, the parallel discharges are rendered stable and will run indefinitely under suitable conditions.

The stability produced by the inductance in series with each cathode is destroyed if a condenser is shunted across the cathodes and it is owing to this fact that the system can be made to oscillate. One mode of operation is as follows:

Suppose that the parallel discharges are operating steadily, the switch 13 being open. Let this switch now be closed (position shown by the full lines); the stability of the parallel discharges is destroyed, and one of them, say that through 5, will be extinguished. The current through inductance 7, which formerly went through 5, must now take the path from 4 through 6, 13, 12, 11 and 7; that is, the inductance 7 now begins to discharge itself into condenser 11. In a very short time the condenser attains a voltage, say V, sufficient to start a discharge in the tube between 5 and 6, hence the oscillatory circuit begins to execute an oscillatory discharge around the path 11, 12, 13, 6, 5, 11. Discharging under ordinary circumstances the condenser would attain at the end of the first half-swing a voltage (V-v) which is reversed in sign to the original voltage V and smaller in value than V. But as soon as the condenser circuit begins to discharge through the tube, cathode 5 is started again and cathode 6 extinguished. The current through inductance 8 must now pass through cathode 5, hence while the oscillatory circuit is executing its first half-swing, inductance 8 is discharging into condenser 11. At the end, or shortly before or after the end, of the first half-swing, therefore, the condenser voltage will not be —(V-v) but —V, which voltage is sufficient to start the reverse discharge between 5 and 6. The condenser circuit now begins to execute its second half-swing, starting cathode 6 and extinguishing cathode 5 again. The condenser voltage tends toward the maximum value (V-v), but the inductance 7 must now discharge into the condenser, so that the voltage V is reached again, and the process repeats itself.

When the system is operating in the manner described the oscillations produced are undamped and practically sinusoidal. The system may oscillate in other ways, however, giving for example rapid series of slightly damped waves, or other types of waves. The manner in which the system oscillates is determined by the magnitude and character of the various constants which enter into the circuits.

In the drawing the cathodes 5 and 6 are shown constricted where the discharge enters them. The cathodes are preferably in this form because better results have been obtained with them than with mercury pools of the ordinary type.

It is found by experiment that in order to obtain steady oscillations the ratio of inductance to capacity in the oscillatory circuit must be very large. The oscillatory circuit can be connected or coupled to the antenna or other circuits in any desired manner; and, under proper conditions, the antenna itself may be the oscillatory circuit or part thereof.

This system may be adapted for use with alternating current supply. Single phase may be employed, but polyphase currents are preferred. Referring to figure 2 which shows the invention adapted for use on a two-phase system, 20A and 20B indicate the two-phase supply, 21 and 23 are the primaries of a pair of transformers, 22 and 24 are the secondaries of the same. The primaries are supplied through the series reactances 25 and 26. The tube 3 is provided with four anodes, 4a, 4b, 4c and 4d. Special care is necessary to prevent arcing between these anodes. The terminals of 22 are connected to anodes 4a and 4b, those of 24 to 4c and 4d. The mid-points of the secondaries 22 and 24 are connected together, and from these midpoints run the parallel paths 7, 5 and 8, 6. The significance of these and the remaining members is the same as in figure 1. In order not to complicate the figure, starting means are not shown. The tube may be started as shown in and described in connection with figure 1, or in a variety of other ways. It is understood, of course, that means are provided for preventing high frequency energy from getting back into the supply circuits.

It will be observed that the extra resistances 9 and 10 of figure 14 are not shown in figure 2 and that series reactances 25 and 26 are shown in figure 2, through which the primaries are supplied. The reason for this is: In figure 1 the extra resistances are necessary in order to limit the starting current, that is the current drawn by the circuits after the parallel discharges are started and before the oscillations have been set up. In figure 2, however, where alternating current is employed the starting current is limited by the series reactances 25 and 26, hence only small series resistances are necessary; hence the form shown in figure 15 is more efficient than that in figure 1. If the transformers of figure 15 are constructed to have sufficient leakage, then the series reactances are unnecessary. All that is necessary is a loose coupling between the primaries and secondaries of the supply circuits.

Aviation News

(*Continued from page 20*)

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Attention was drawn, on more than one occasion, by manufacturers to the importance of maintaining the interest of workers in aircraft factories in the highly important but generally monotonous work on which they are employed. Engaged, as they frequently are, on the production by a repetition process of some small part of an aeroplane, these men and women find it difficult to realize that they are contributing effectively to one of our most valuable instruments of warfare. It was accordingly arranged that Captain Ewart, R. A. F., well known as a writer by the name of "Boyd Cable," should visit various squadrons at the front and gather materials and photographs for lectures concerning the exploits performed with various types of aircraft for delivery to the workpeople engaged on the manufacture of those particular types. Captain Ewart delivered several series of lectures which, judging from the reports received from the factories concerned, proved a very great success.

Electrical Digest

The Production of Nitrogen From the Atmosphere

THERE has been erected at the United States Department of Agriculture's Experiment Farm at Arlington, Va., the largest experimental plant in the United States for the production of nitrogen from air. The nitrogen so produced is combined with hydrogen to form ammonia, which can be used in the manufacture of explosives and fertilizers. Experiments with the view of increasing the efficiency of the process are now being conducted by the Bureau of Soils. The Haber process of manufacturing nitrogen is being employed. This process involves the production of ammonia from hydrogen and nitrogen. The two gases are mixed in the proper proportion, put under high pressure, and subjected to intense heat. They are then passed over a spongy iron, whereupon a portion of the mixture combines to form ammonia.

The Aluminum Production of the United States

THE United States is far in the lead among the Aluminum producing countries of the world. In fact about one-half of the world's output is produced in this country.

A recent compilation by the National City Bank of New York shows that the production of aluminum in the United States has grown from 60,000 lbs. in 1890 to 7,000,000 in 1900, 48,000,000 in 1911, 100,000,000 in 1915, 140,000,000 in 1916, and approximately 180,000,000 in 1917.

It is stated that aluminum is proving an acceptable substitute for tin in the metal industries. Its cost is no greater than that of tin, which is an important matter to the United States, because this country produces no tin and purchases large amounts abroad.

Most of the aluminum produced at present in the United States is employed in aeroplanes, automobiles, helmets, and cartridges.

Pauxite, the mineral from which the aluminum is produced, is found in many parts of the United States, but the bulk of it is furnished by the State of Kansas. The finished product is made in various parts of the United States, the most important plants being located at Niagara Falls, N. Y.

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The Monthly Service Bulletin of the NATIONAL WIRELESS ASSOCIATION

Founded to promote the best interests of radio communication among wireless amateurs in America

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THE proposed extension of the draft ages to include men from 18 to 45 years, calls for serious attention on the part of former amateurs in the United States, particularly those who were below age in the first call.

An increased army naturally will require an increased number of radio engineers, operators, mechanics, repairmen, and installers. Amateurs approaching the age of 18 and up to 21 years ought to take full advantage of their spare time, and prepare themselves for an appointment in the radio divisions of either the army or navy. This will mean an immense saving of time and labor to the government. Every means at their disposal should be grasped to gain a practical education in wireless. This can be obtained by joining a local radio school, or by forming a local radio club for the sole purpose of instruction in the theory and in the International Code.

A considerable amount of self education can be carried on. Literature is now available for the study of the art in all its phases. Code practice outfits are inexpensive, and the Marconi-Victor Records can take the place of a special instructor. It is not difficult for the beginner to master the fundamental principles of wireless transmitting and receiving apparatus if he will first make a thorough study of the elements of electricity and magnetism. By close application, he will finally arrive at the point where he requires instruction on actual equipment. A radio school will generally be found within a reasonable distance.

It is safe to say that the new draft will include thousands of wireless operators, therefore, why not start instruction today. Putting it off will never do. Skilled men are the requirement of the hour. The selected man should not wait until he has been assigned to a cantonment. He should go to camp with a complete mastery of the basic principles. His expertness will come under the observation of some superior officer sooner or later, and before he believes it possible, he will receive a higher appointment.

The amateurs of this country have responded nobly to the government's call for volunteers. It is next to impossible to locate a former well-known experimenter. He is either in the front ranks with Uncle Sam's Army or in the laboratory doing research work in radio. Many have received commissions, rapid promotion being possible because of the experience gained through their home experiments.

A man in charge of a large government school told the writer recently that students who were formerly amateur experimenters, outshine all others from every standpoint, and he expressed the desire that the government would in the future pay particular attention to enrolling first, young men who had operated experimental wireless stations in years gone by. He declared that they possessed a certain keenness in manipulating wireless equipment which the land line telegraphers required several months of close application to acquire.

In preparing themselves for government service several inquiries have been received from various amateurs which in a general way may be stated as follows: "What shall we study to fit ourselves for government radio work?" To this we reply that that aspirant should master first the International Telegraph Code. He should follow this by study of elementary electricity and magnetism; next—the alternating current dynamo and transformer. He should learn how to use measuring instruments, and afterward take up the radio frequency circuits of the wireless transmitter and receiver.

The process of tuning is next in order; then the principles and operation of the vacuum detectors. He should study the fundamentals of undamped wave transmitting and receiving apparatus particularly, the arc transmitter and the beat receiver.

Within a space of three to six months, the beginner should acquire a fair general knowledge of wireless telegraphy, and then by taking a finishing-up course at a properly equipped radio school, he will be a well-balanced radio man. The foregoing deserves serious consideration.

The following is a statement of fact, but for reasons well known to ourselves, the proper names of the gentlemen involved cannot be published:

Bill Jones and John Smith lived on the same block, and both were deeply interested in amateur wireless telegraphy. Jones constructed a haphazard station without giving serious attention to basic principles. He used his apparatus merely as a toy, the major portion of his time being spent in filling the ether with nonsensical conversations. He never studied a book on radio and sidetracked all attempts to study the theory underlying the working of his apparatus. Like many others in the same class, his interest waned until his station was only heard occasionally.

John Smith, on the other hand, read every piece of available wireless literature, and he conducted a series of experiments to determine the how and why of his apparatus. He built his instruments in accordance with well-known principles, and every test he made was for the purpose of making a new determination. He was often laughed at by Jones for taking the art so seriously, but nevertheless he plugged away until his station had a reputation of being the best in that locality.

Both of these gentlemen being within the draft age, they decided to enlist in the Navy as radio operators. Jones enrolled in this particular division because he thought that he was going to take on "something easy," but Smith entered with the sole idea of doing the greatest possible good to the Government. They joined a prominent Naval School at the same time and were placed in the regular routine. Jones held that if he became a fair wireless operator he was doing his part, at least in the eyes of the neighbors in his home town, but Smith had a larger vision, and he did everything possible during his training period to further his knowledge of the art.

To make the story brief, Smith is now a Radio-Gunner in charge of wireless operations on one of the largest vessels in the Navy. Jones is a third-class electrician on a merchant transport, and the chances are that he will continue in this capacity for the duration of the war.

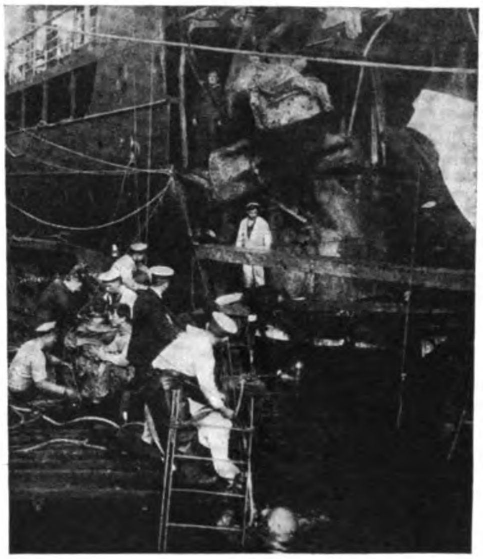
Would you rather be Jones or Smith? If Smith, then go back and read the first article in the bulletin again.

Torpedoed!

(Continued from page 35)

the men were without food for eight days. They had even eaten the cats that were on board. The crew had given up all hope of being rescued, as several ships had sighted the chaser but thought it to be a submarine and changed their course.

A lifeboat filled with food supplies was sent out to her. We then took her in tow and continued on our voyage. This happened by coincidence on my birthday—the 13th, surely for the Frenchmen, a lucky 13th.



Divers at work searching for the bodies of firemen who lost their lives

Later we learned that there were seventeen of these U-boat chasers built in the United States for France, and only eleven reached port.

We arrived at St. Thomas, Bermuda, two days later with the S. C. 171 safely in tow. She was taken in by a tug and I have heard nothing further concerning her. After coaling, our voyage to New York was resumed without further incidents.

Lack of skill in story-telling has probably made this a pretty poor yarn, but I am hopeful that in it readers will see that submarine attacks are still one of the grim features of the present war. We wireless operators have our trials at sea just as frequently as do those who are fighting "Over There." But the knights of the sea roads are winning their victories and the spirit of '76 assures a certain triumph. America's day on ocean cross-roads is coming; soon the Hun must seek shelter. And when we have the upper hand, well—if Sherman thought war was hell, the Kaiser's opinion surely will not look well in print.

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Harvard Radio School

Uncle Sam is sending out every week from fifty to one hundred wireless operators from the big Harvard plant at Cambridge, Mass., which was transferred to the Government a year ago as a radio finishing school. It is the only institution of the kind in the country, and the classes have in the aggregate 5,000 ambitious youths.

Memorial Hall, perhaps the most famous of all the Harvard buildings, and wherein generations of undergraduates have dined, is the main eating establishment for the radio army.

But this old hall has its quiet period, for on payday, which comes twice a month, only a handful go there to dine. The radio boys walk with the "ghost" and go him one better by taking an eight minute subway jump to Boston, where they come up for air and a change of scenery.

The radio students notably are orderly. They are scattered over a wide area, many of them lodging in private homes without official restraint, yet police and military records reveal blank blotters so far as they relate to radio students.

This being a finishing school, only those who are able to copy ten words a minute in the Continental code are admitted for the sixteen weeks course. To be sent out for service at sea they must be able to receive twenty-two words a minute, the minimum grading. There are many experts among the teaching force whose speed runs up to thirty-two words a minute, but beyond that a radio message would be hard to get. From three to six operators are assigned to each ship. With the large number of vessels building for the merchant marine and the navy, the radio school is doing its best to turn out experienced operators as fast as possible.

The radio men have come from every State in the Union, many of them under draft age, and generally eager for active service.

Warming the Aviator's Feet

ELECTRICAL means of keeping an aviator's feet warm is the basis of a new apparatus recently devised by a New York inventor. The illustrations show the arrangements.

This shoe-warmer equipment comprises an insole having the general appearance of the commonly used slip insole, except for the two plugs projecting about one-eighth inch from the bottom.

When the insole is placed in position in the shoe, the two small plugs fit in two sockets which are sunk about one-eighth inch in the heel. These sockets are the terminals of two small insulated wires, which are connected to the terminals near the top of the shoe. These terminals may be made invisible if desired.

Electric current is brought to the terminals through small insulated wires attached to the inside seam of the trousers; these wires connect with the source of electric current at the waist so that there are no loose wires to inconvenience the wearer.

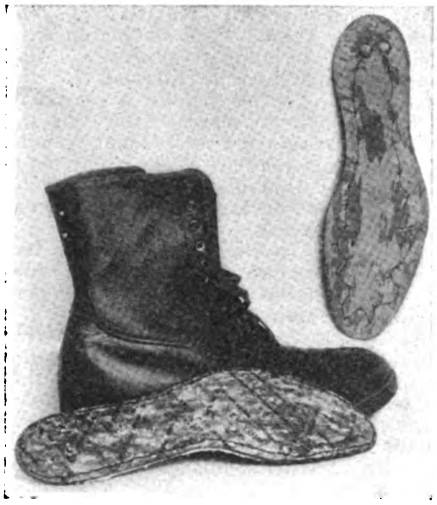
The amount of current consumed is very small indeed, two ordinary sized flashlight batteries being sufficient to keep a person warm for a number of hours.

While it was to give aviators a practical means for keeping themselves warm that brought about this invention, its use is not by any means restricted to aviators' needs. Look-outs on naval patrols, submarine crews, observers in observation balloons, soldiers convalescing, motor car and motor truck drivers, and all others who are subjected to the rigors of outdoor life can use this simple equipment to advantage.

Showing method of wiring

An obvious application would be to our troops operating in the arctic region of Siberia this winter, whether fighting or convalescing. The man using this equipment is not only going to be kept comfortable, he is going to be very much more efficient.

It would seem also that this invention will prove of great value to the man about town this winter. Some of us will not have all the coal we would like to have, so that other means will have to be resorted to. From a coal-saving and economic point of view, this idea can't be beaten, the inventor claims; by using one's electric lighting circuit, the feet (which affect the temperature of the whole body) can be kept warm for about 1 cent a day. Not only can a person be kept comfortably warm in this way, but they may enjoy fresh air at the same time; windows need not be sealed up in order to retain the warmth, the stale and injurious air which is the general rule with every other heating means being dispensed with. Thus lungs are kept strong and in a condition to resist the extremely cold air of outdoors. It is well known that more colds, pneumonia and grippe are brought about through people going out into the cold air after sitting for some time in a carefully closed-up office or room than by any other means. The shoe-warmer equipment is expected to do away with this danger.



Style of insoles with wiring and contact points in place

Queries Answered

Answers will be given in this department to questions of subscribers, covering the full range of wireless subjects, but only those which relate to the technical phases of the art and which are of general interest to readers will be published here. The subscriber's name and address must be given in all letters and only one side of the paper written on; where diagrams are necessary they must be on a separate sheet and drawn with India ink. Not more than five questions of one reader can be answered in the same issue. To receive attention these rules must be rigidly observed.

Positively no Questions Answered by Mail.

F. R. D., Mobile, Ala., inquires:

Ques.—(1) Up to the time of the United States' entrance into the war, what was the most commonly used type of oscillation detector?

Ans.—(1) It may be said that the carborundum rectifier was the most popular up to that period, due mainly to its simplicity, ruggedness and stability. Vessels fitted by the English Marconi Company usually include a magnetic detector with the radio equipment. This is by far the most stable and fool-proof of all oscillation detectors, but it possesses the disadvantage that it is not sensitive on the shorter range of wave lengths. Its reliability in operation, however, offsets its shortcomings in that respect. The two and three-electrode vacuum tubes were favored up to that time, but were expensive to build and operate as compared to the simple crystal.

Ques.—(2) I have noticed that there are a variety of methods of connecting the potentiometer and battery to the carborundum rectifier. Which one is preferable?

Ans.—(2) There are three methods of connection as shown on page 134 of "Practical Wireless Telegraphy." The connection generally favored is that of Fig. 153b. Fig. 153c are the connections used by the English Marconi Company. The connections of Fig. 153a are now practically obsolete.

Ques.—(3) How does the operator obtain the best operating adjustment of the carborundum crystal?

Ans.—(3) If the receiving tuner is fitted with a buzzer tester, the buzzer is set into operation. The operator then tries various points of contact with the crystal with simultaneous adjustment of the potentiometer, until the loudest signals are obtained in the head telephone. It is difficult to give specific instructions in advance. Also remember that the current from the local battery must flow through the crystal in a definite direction. The correct polarity is readily determined by experiment.

Ques.—(4) What is meant by a "standby circuit?"

Ans.—(4) This is the circuit that the receiving operator employs when he desires to receive response from several transmitting stations operating on slightly different wave lengths, without accurate tuning. For "standby" work, the operator employs close coupling between the primary and secondary coils of the receiving transformer.

Ques. (5) In the circuit of the three-electrode vacuum tube, I often notice a resistance connected between the grid and filament. What is the function of this connection?

Ans.—(5) This resistance is employed to prevent an extraordinary negative potential piling up in the grid condenser, or on the grid itself. It can be shown that if the grid of the vacuum tube is charged to a sufficiently high negative potential, the plate circuit will open; that is, the passage of current from the plate to the filament will be obstructed. Hence, when a cascade amplifier is employed, it becomes necessary to connect a resistance between the grid and the filament of the vacuum tube, in order that the fluctuations of the grid potential in the second or third tube will not become so great as to render the vacuum tube inoperative.

* * *

A. B. L., Clarksburg, W. Va.:

We cannot publish details concerning the scope of instruction given at Naval Radio Schools. The Navy has both general schools and "finishing up" schools. The appointments which Naval students obtain depends primarily upon their rate of advancement. This is a matter on which we cannot give you much information.

* * *

G. R. L., Washington, D. C., inquires:

Ques.—(1) Assuming a short-wave condenser to be connected in series with a wireless telegraph receiving set; will the antenna system respond to the longer waves in the position of maximum capacity of the condenser or in the position of minimum capacity?

Ans.—(1) The shorter wave length adjustment will be obtained when the capacity of the condenser is near to zero. Moreover, this condenser will be

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a greater determining factor in changing the wave length when its capacity is equal to or less than that of the wireless telegraph aerial.

Ques.—(2) When the statement is made that the decrement of a wireless transmitter is 0.2, what does this expression indicate?

Ans.—(2) The decrements of damping indicates the rate at which oscillations die away in a circuit producing damped oscillations. It is in reality an expression which shows the energy losses in a given circuit. A decrement of 0.2 signifies that each spark discharge in the closed circuit of the wireless transmitter sets up approximately 25 complete oscillations in the antenna circuit before the amplitude of the last cycle is .01 of the amplitude of the initial cycle. The logarithmic decrement of damping is the logarithm of the ratio of the amplitude of two successive oscillations in a wave train in the same direction; that is, it is the decrement per complete cycle.

Ques.—(3) Can you give me a simple explanation of what is meant by a quenched spark?

Ans.—(3) The phenomena of quenching is obtained to a greater or lesser degree with all types of spark gaps. A proper quenched spark gap is one that permits little or no retransference of energy from the aerial circuit back to the closed circuit. In other words a quenched spark gap permits the closed circuit to oscillate through 2½ or 3 cycles, after which the insulating qualities of the gap are restored and the oscillations are suddenly cut off. This permits the aerial circuit to oscillate at its own frequency and damping, and generally results in oscillations of feebler decrement than are obtained with spark discharges, in which the quenching feature is not so pronounced.

Quenching, in a sense, means rapid cooling of the gases around the spark discharge electrodes. If the gases cool so rapidly that the gap's insulating qualities are restored after two or three cycles of current, then the most effective quenching is secured. The most effective way of obtaining rapid cooling is to cause the spark to discharge between large copper plates, the sparking surfaces of which are separated by, say, 1/100 of an inch. Other means, however, may be used for cooling the gap.

Ques.—(4) How can the transmission range of a radio transmitter be predetermined?

Ans.—(4) Formulae has been presented for this calculation, but they are only approximations. The better way to determine the range of transmission is to conduct actual experiments to this end. Of course, engineers have made observations through years of experience, and they are enabled to predetermine with a fair degree of accuracy the probable range of transmission. In fact radio engineering has been reduced to a scientific basis, enabling practically all calculations to be made in advance. Local conditions, however, may upset the calculations, particularly in a region where there is considerable atmospheric electricity. The approved method is to construct a transmitter of more power than is required to cover a given distance. This permits communication to be carried on under adverse circumstances.

* * *

P. R. A., U. S. A.:

Ques.—(1) In the operation of our transmitting apparatus the aerial ammeter fluctuates badly, that is, if we depress the key, the pointer will jump from 6 to 10 amperes, and irrespective of how we adjust the apparatus this will continue. Have you any advice to offer?

Ans.—(1) This may be due to a variety of causes. The ammeter itself may be defective, that is, there may be leakage in the insulation, or the antenna wires may swing to contact with guy wires on the vessel. If a multiple quenched spark discharge is employed the insulating gaskets may leak air, and some of the plates are possiby short-circuited. If the brushes on the motor generator are making good contact, and the transformer is apparently in first-class condition, it would be well to take the quenched spark discharger apart, clean the plates, and install a new set of insulating gaskets. The plates should then be clamped in their rack with good pressure. The spark should then be allowed to discharge through the gap for a period of at least a half an hour. After this the set can be readjusted for resonance, until the maximum reading of the ammeter is secured. If this does not remedy the trouble, look for leakage in the insulation elsewhere.

Ques.—(2) In the advent that a frequency meter is not supplied with a radio set, how can the frequency of the generator be obtained?

Ans.—(2) A small speed indicator should be applied to the shaft noting the revolution per minute. Divide this by 60 to obtain the number of revolutions per second. Assume that the generator made 33⅓ revolutions per second, and it had 30 field poles. Then the frequency equals

$$\frac{33\frac{1}{3} \times 30}{2} = 500 \text{ cycles per second}$$

In other words, the speed of the armature per second multiplied by the number of field poles and divided by 2 will give the frequency of the generator.

Ques.—(3) How can we remedy sparking at the brushes of the motor?

Ans.—(3) Clean the brushes of the commutator thoroughly. If the commutator is grooved, remove the armature from the machine and have it turned down in a lathe. Be sure when replacing it that the brushes are placed in the neutral field. If the armature coils are not defective, this should remedy your trouble.

Ques.—(4) Can a carborundum crystal be used as an oscillation detector for undamped waves?

Ans.—(4) Not unless a local radio frequency oscillation generator is supplied. If, for example, a three-electrode vacuum tube is connected up for the production of radio frequency currents, and it is placed in inductive relation to the aerial circuit, beats will be generated in the receiver circuits, and they may be detected in the circuits of the carborundum rectifier.

Ques.—(5) Can a carborundum crystal be employed to take down wireless telephone conversations?

Ans.—(5) Any type of oscillation detector responsive to damped waves will be suitable for this purpose.

* * *

A. P. R., Student at a Naval Radio School, inquires:

Ques.—(1) I have often heard the expression "feedback" employed in connection with receiving apparatus in wireless telegraphy. Just what does the term mean?

Ans.—(1) This term is applied in connection with the regenerative circuits used with the vacuum tubes. In a feedback circuit, the plate circuit is coupled to the grid circuit either inductively, conductively or electrostatically, such a circuit is essentially the regenerative circuit first shown by Armstrong.

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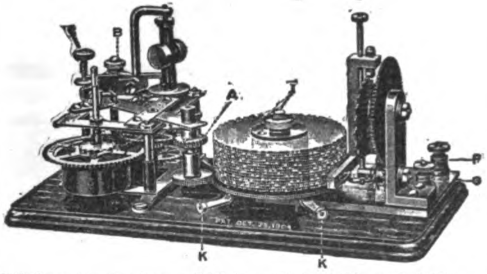

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Volume 6

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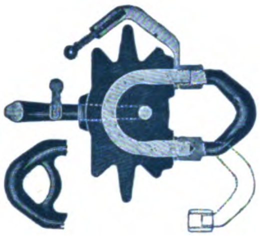
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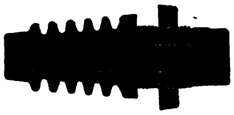
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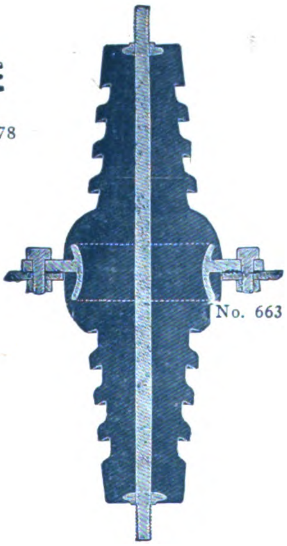
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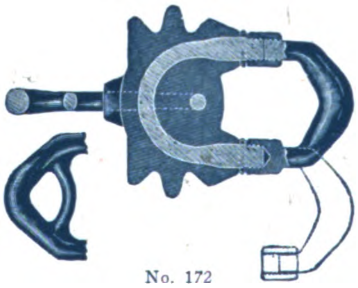
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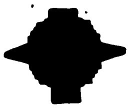
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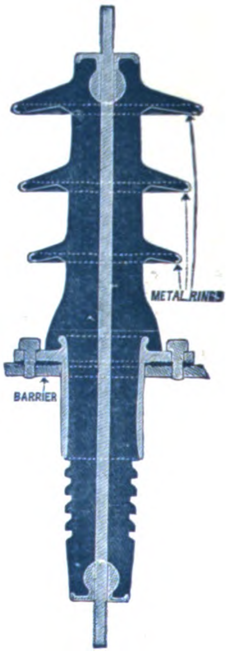

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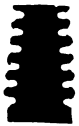
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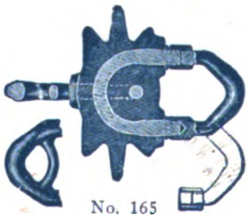
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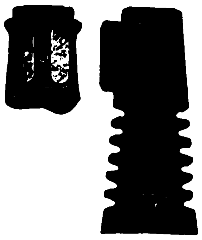
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The Wireless Age

Edited by J. ANDREW WHITE

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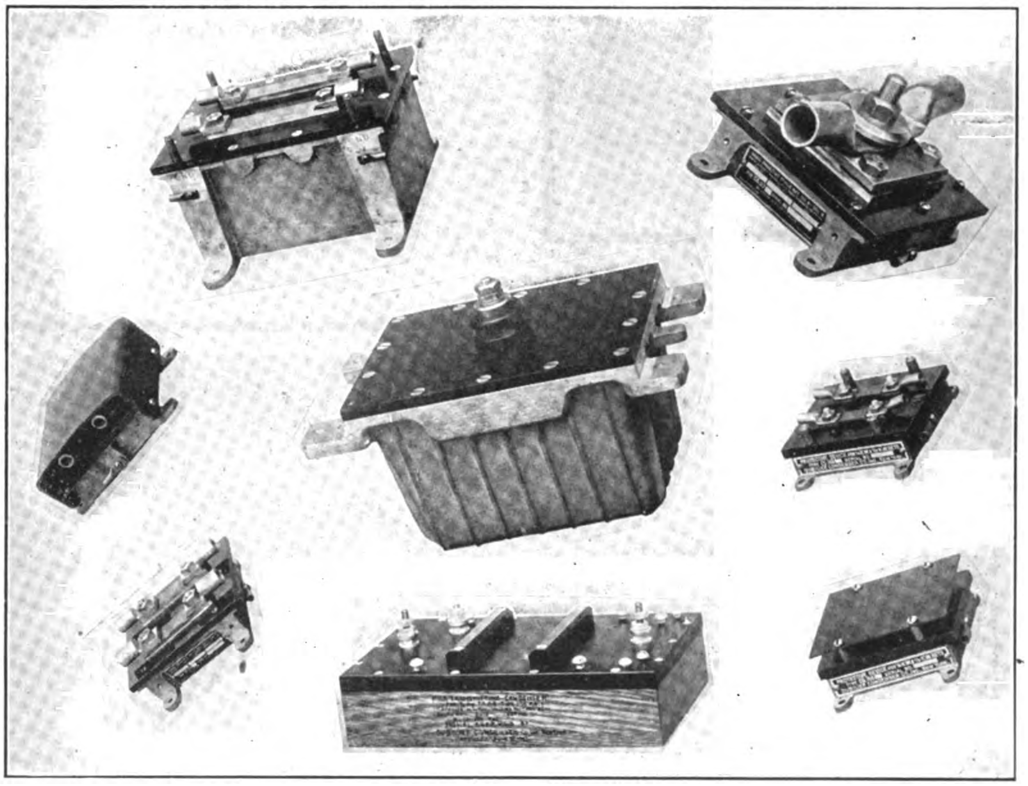

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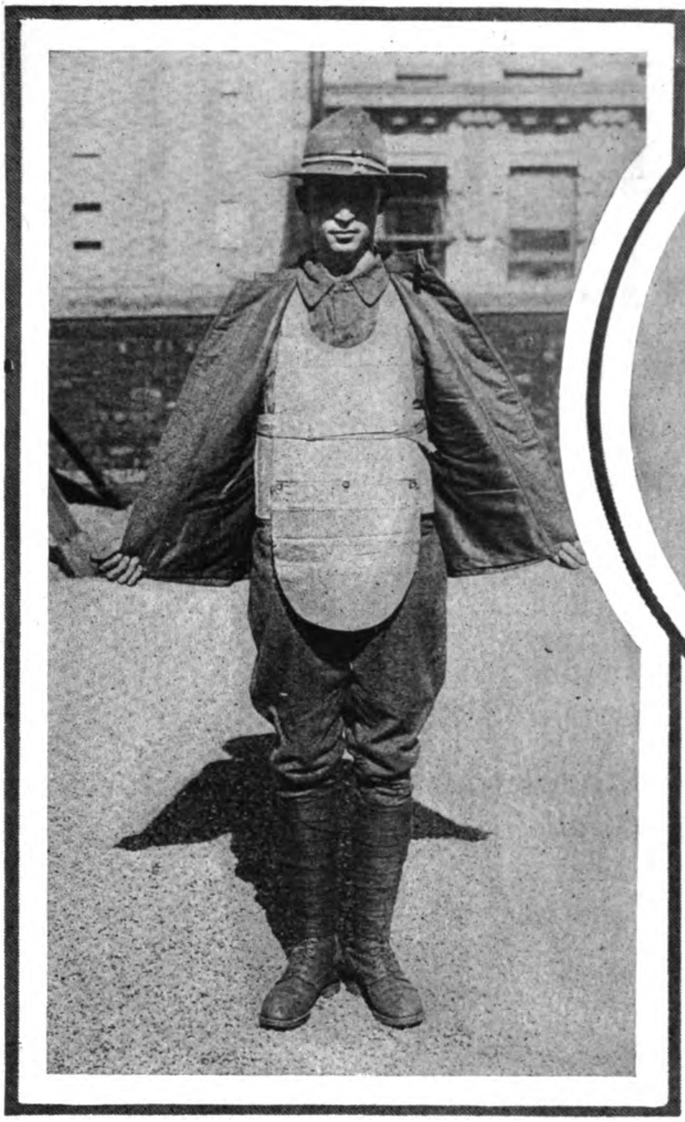
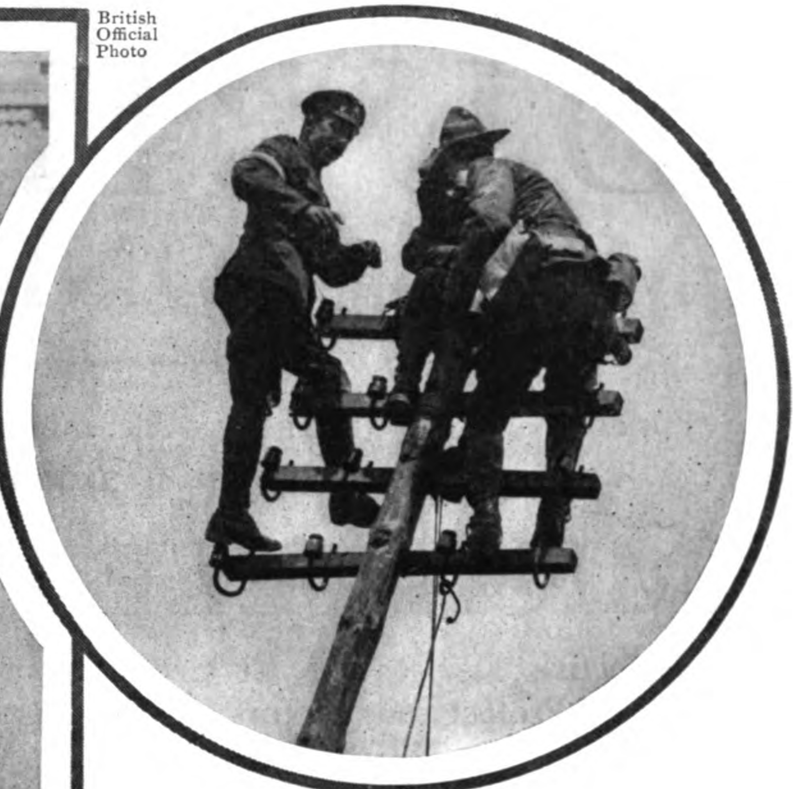


British Official Photo



Above, in circle, the union of the allied armies visualized in members of both British and American Signal Corps working side by side in the construction of a telegraph line on the western front

To the left, protective armor for shock troops. The bullet-proof vest shown will stop revolver bullets at any range and resists shrapnel at 1200 feet velocity per second. It is flexible and scientifically made to protect the sides and abdomen and all vital organs of the body

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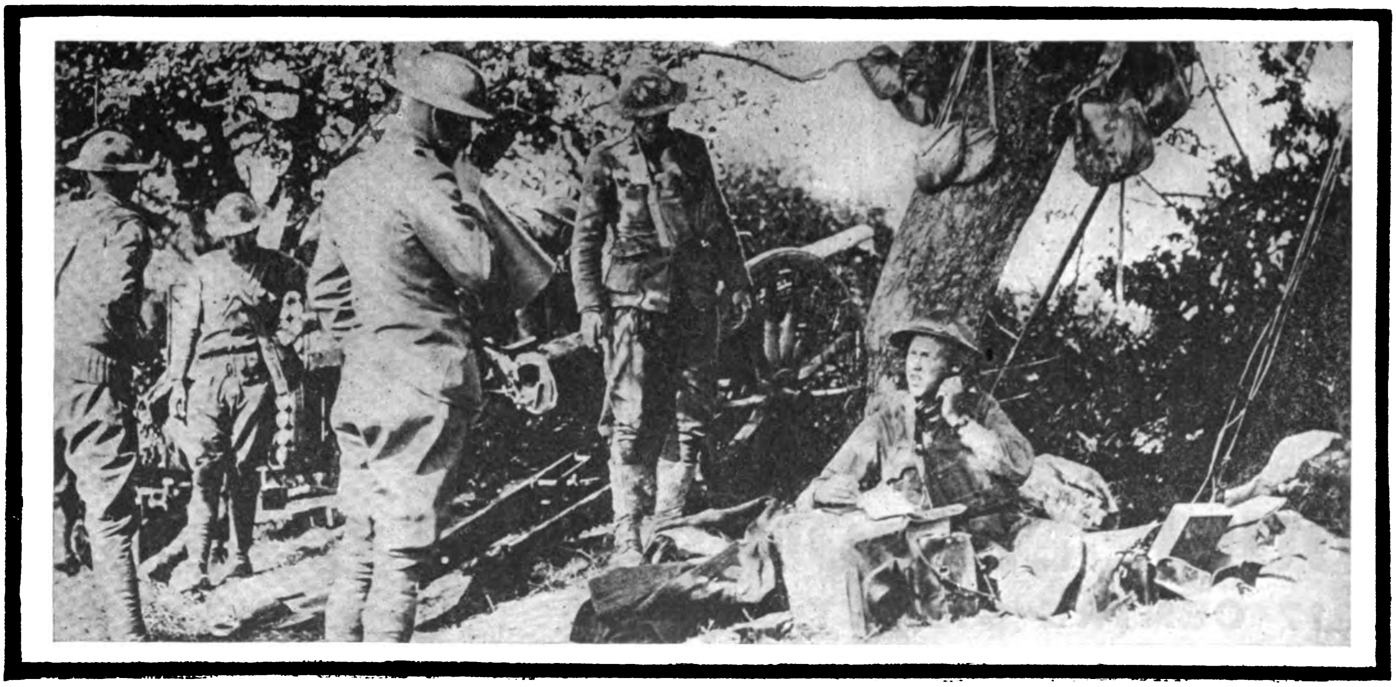


This photograph, an official one taken by the Signal Corps in France and released by the Committee on Public Information, shows how closely allied is electrical communication with artillery ranging in modern warfare. The battery captain, with the megaphone, is withholding fire of his field pieces until full data is received by the signalman at the foot of the tree

Vol. 6. No. 2. November, 1918

THE WIRELESS AGE

WORLD WIDE WIRELESS

Wireless Is Greatest Aid to Alaskan Education

A SCHOOL teacher's job in Alaska is anything but a bed of roses. Seventy native schools maintained by the government throughout the territory are in charge of men as resourceful as Charles N. Replogle, the government teacher at Norvik, who is required to make a study of the reindeer industry in addition to his hundred and one other duties.

The Eskimo is not as isolated as the geography would indicate, for at some of the schools wireless stations have been established and news of the world is flashed to them. Concerning his enterprise Mr. Replogle says:

"The greatest difficulty experienced in teaching the Eskimos is not in teaching them regarding the facts of life, but in getting those facts applied to their everyday living. Instruction has, therefore, been of the most practical kind. The morning exercises are largely taken up with singing and telling the wireless news from all over the world, as received at our wireless station. So eager are the people to get in touch with the world that it is common to have the schoolroom full of adults to hear the news. In order to understand it they must become acquainted with geography and history. These studies have given them a comprehensive viewpoint such as was never possible to obtain through the abstract textbook method of teaching. This has had much to do with the change of the customs of the people themselves. To them the United States and its government is no longer a matter of a man or two, but is a big tangible reality.

"The wireless has done more in one winter to awaken the slumbering intellect of the native than years of abstract bookwork. His education has come to him imperceptibly and has fastened itself upon the consciousness without definite effort on his part. There is no longer any balancing of the 'native custom' against the new knowledge. In room No. 1 a class was organized for the study of electricity and the "radio" code. With the very limited general knowledge of the pupils, the progress was necessarily slow and very tedious."

British Take German Wireless in Spitzbergen

SEIZURE by a British expedition of German mining property and other development plants in Spitzbergen, including a big wireless installation, is reported by the London Express. The coal and iron deposits will be of the greatest importance to Great Britain and the allies. The expedition sailed a few months ago under the protection of the British navy. Sir Ernest Shackleton, the Antarctic explorer, was the commander, but he was subsequently obliged to leave to take up other duties. His successor, F. W. S Jones, took a large number of miners, an enormous quantity of mining material and supplies sufficient for three years. Work is now going on on a large scale. Capt. Wild, who was with Shackleton in the Antarctic, is in charge of operations. Mr. Jones says the expedition met with considerable difficulties, including encounters with eight German submarines.

Believe Austria Has Secret Wireless Station

A Vienna message to the Frankfurter Zeitung states that the existence of a secret wireless installation is suspected at Prague, and the Austrian authorities are displaying considerable anxiety regarding it. Close search having failed to discover it, the installation is thought to be of a movable character.

Balloon Cable a Cross-Continent Aerial

THE wireless station at Arcadia, Cal., by using for aerial the cable of a balloon, put aloft from the training field, has intercepted messages sent by the Brooklyn Navy Yard wireless stations, according to an announcement by the War Department. This balloon cable probably makes the highest aerial in the world.

This announcement was made by the Division of Military Aeronautics, indicating increasing efficiency in both the work of students and the equipment of the War Department's various balloon training fields. The balloon school at Arcadia has 106 miles of wire in use in teaching military communication. For the purpose of demonstration it has a complete system of wiring strung as it would be in the front line trenches on the battlefield. Communication posts and stations for all kinds of messages are used by the students the same as soldiers use them at the front.

A good part of the country southeast and southwest of Arcadia is laid out with lines of communication to this balloon school, similar to part of a sector at the front. All of the balloons, when aloft, are so wired that they can be lined together with any trench, doubled up for any work together, or they can be cut off from the trenches and talk only with their own chart room and winch or operating crew on the ground below.

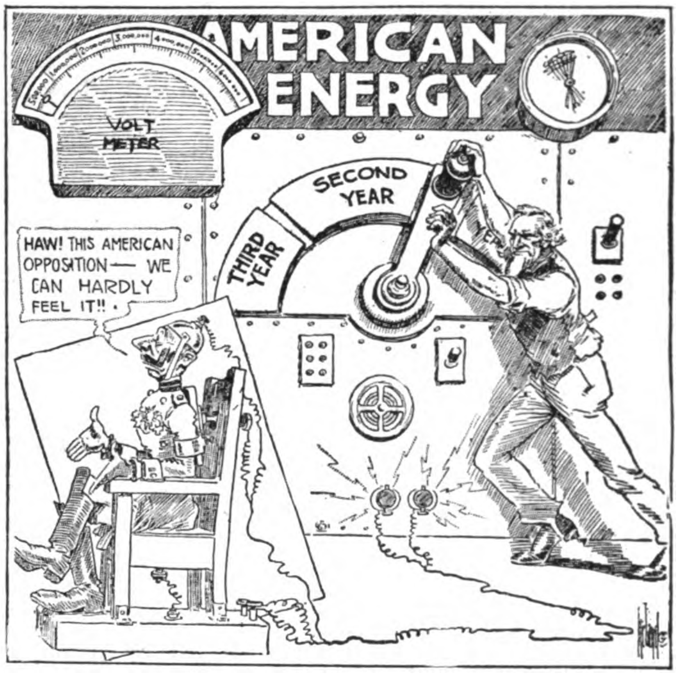
Isle of Pines Radio Resumed

THE Department of Commerce has received from the American Consul at Isle of Pines, Cuba, information that that island once more is in telegraphic communication with the world at large. A new wireless station has been constructed to replace the one destroyed by a hurricane at Nueva Gerona last September.

The new station is claimed to be far superior to the one destroyed and it is said to be the second largest in Cuba and to have a radius of 500 to 600 miles in the daytime and about 1,000 miles at night. The tower is 250 feet high and the cost of construction of the station is estimated at $20,000. Messages can be sent direct to the United States at night, via Arlington, Va., but may have to be sent via Havana, Cuba, in the daytime.

A Wireless Message Around the World

A FEW years ago the news that a wireless message had enveloped the globe would have been astonishing, would have been the news of the day, notes the N. Y. Times. News values have altered since August 1, 1914, and on October 2 the report of this event was printed briefly. News value is an expression which, being translated, means "what people are interested in," and in these days proportions are altered.



Ireland in the Columbus "Dispatch"
"Don't be impatient, Bill, you're going to feel it"

The short report printed was that direct communication between England and Australia, a distance of 12,000 miles, had been established. Twelve thousand miles is half way around the globe. But since the electromagnetic waves move equally in all directions, this message moved also in the opposite direction to that in which it was aimed and covered the other 12,000 miles. It did more than that, it enveloped the entire globe in every direction. Puck offered to spread a girdle around the world; this scientific Puck changes the girdle into a mantle.

That, however, is a feature of the report which only tickles the love of the marvelous. The practical side of it is not the encirclement of the globe, but the sending of the message to the intended receiver of it halfway around the circle. "The messages were received with perfect clearness." They went from the Marconi station at Carnarvon, Wales, to the Amalgamated Wireless Company of Australia at Sydney. The abounding achievements of science during the war, many of them directly caused by the war, are getting little attention compared to the bloody drama itself, but after the war they will come into their own.

American Marconi on Preferred List of Peace Stocks

STOCK of the Marconi Wireless Telegraph Company of America has recently shown marked activity in the New York Curb market. A leading specialist brokerage house is bidding 4⅛ for the holdings of its customers, stating that "among the so-called Peace Stocks, Marconi Wireless is on the preferred list." The statement issued adds that this is due to the general admission in commercial circles that the business of the company will expand enormously all over the world. The opinion continues that, when the war is over, Marconi Wireless of America must be regarded as one of the best and most profitable investments in the industrial group, and the steady accumulation of this stock, at a little below par ($5) a share, is for some of the best-posted authorities in Wall Street, who recognize that the outlook for Marconi is very bright.

It is intimated that the strength of the issue has partial foundation on the action of the company on August 1, when a dividend of 5 per cent. was paid, the belief being general that this dividend is the forerunner of regular annual or semi-annual dividend payments.

Naval Radio Men Score 100 Per Cent. on Loan

THE Eleventh Battalion at the Naval Radio School at Boston subscribed 100 per cent. to the Fourth Loan. The average subscription of each man was $61.22. As we go to press, $125,000 has been obtained at the school, the Eighth Company ranking second with 46 per cent. subscribed. Lieutenant W. D. Fleming, assistant paymaster, was in charge of the station's campaign.

France Completes Radio Chain With Giant Station

THE American Army will soon be sharing with the French in the operation of the highest and most powerful wireless sending station in the world. This is now nearing completion on the French coast—the point cannot be stated—and its giant towers can be seen rising 810 feet, or 300 feet higher than the Eiffel Tower. Soon it will be in direct touch with America, with far more power than ever before, supplementing the cable for transatlantic service and perhaps with its new power rivaling the cable for quick communication.

All along the front small wireless stations have been set up to intercept enemy radio exchanges and locate enemy stations. Messages are picked up from all the capitals of Europe, and especially from the larger German cities. This practice of intercepting messages seems to be universally accepted as a war necessity, and the crop daily gathered includes those from friends as well as foe. The enemy has many small radio stations along the front which are in constant communication with Berlin and Hanover, the two central enemy stations.

The American Army controls a quadruple cable line across the English Channel, which connects the French telegraph and telephone system directly with the English lines. Thus American officials are brought together for direct immediate exchange between Paris, London and American headquarters at the front.

The Signal Corps has undertaken a huge work with some 3 to 4 per cent. of the entire Army—or about 35,000 officers and men in a force of 1,000,000 men—maintaining the steady flow of communication throughout this nerve system of the American Army.

Periscopes and Wireless on Army Tanks

YANKEE ingenuity provided many surprises for the Germans in the St. Mihiel drive. Some of our tanks were equipped with periscopes, enabling the crews to look over the high ground in front of them.

The tanks attached to the American corps were constructed in France in accordance with American plans. All are manned by American crews. The machines are small, fast and powerful two-seaters, equipped with strong offensive armament.

Each carried a wireless outfit, and many a message was flashed from tanks to airplanes, which, in turn, were sent back to headquarters in the rear.

The heavier armor makes our tanks nearly proof against the German anti-tank rifles except for certain direct hits.

One American chauffeur showed the greatest skill in conducting his monster, stamping out the German machine-gun nests by reversing one caterpillar and putting full speed on the others, thus turning round and round till the enemy strongholds were crushed.

New Galena Discovery Cuts Price From $112 to 7 Cents Per Pound

THAT the unusual type of galena ore, used by the government in wireless receiving apparatus and formerly purchased from abroad at a cost of $7 per ounce, is found to some extent in two mines of Utah—the Tintic Standard and the Scranton, both of Tintic—is a fact that is leading to still further search for larger deposits of the much sought for metal.

Only a short time ago the government had the burden of the $7 per ounce price lifted by the discovery, made by S. M. Soupcoff, of Salt Lake, of a quantity of the ore in Smuggler mine, Aspen, Colo., which was purchased at the price of 7 cents per pound. The ore, about ten tons in volume, occurred in a big pocket and the government bought all there was. This will last probably a year, but not much longer, owing to the rapid growth of the wireless industry, and the search for another deposit equally as good is consequently kept up.

Captain E. J. Raddatz states that the desired ore, in small quantities, had been found in the Tintic Standard mine, but never in a quantity sufficient to make handling it worthy of consideration from a commercial standpoint. A similar ore has also been found in the Scranton, a shipping property of the Tintic district. This, too was only in small quantities.

The ore required in the making of detectors for wireless is the purest galena that can be found, 86 per cent lead.

Enemy Aliens Barred From Jersey Coast

UNDER a Presidential order issued October 2, practically the entire territory from Rockaway to Point Pleasant, N. J., along the ocean front and for a distance averaging three miles or more back is made a zone barred to German aliens except under permit.

Rockaway Point, all of Staten Island and all of the New Jersey shore resorts come within the restrictions of the order, which was issued as a means of shutting off all possible communication between the shore and submarines operating at sea.

It is estimated by the Federal authorities that approximately 15,000 Germans are affected.

The order provides that "no German alien enemy shall reside in or continue to reside in, remain in or enter any of the areas so prescribed, except by permit of the President and under such limitations or restrictions as the President may prescribe."

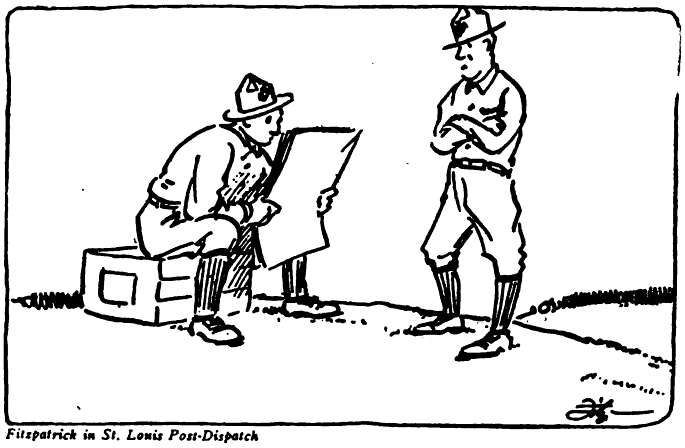
Where it is deemed advisable permits will be issued by United States Marshals of the affected zones, with the approval of the United States Attorneys or the Alien Enemy Bureau of the Port of New York.

Since submarines first made their appearance on this side of the Atlantic, reports have come persistently to the officials of the Army and Navy Intelligence of lights flashing from the shore and the operation of secret wireless stations. The Highlands of Navesink and the high points on Staten Island have been repeatedly subjected to investigation, as have other points further south on the Jersey Coast.

In one case a small dismantled wireless apparatus was found in the possession of a German. While proof has never been obtained of actual communications sent to sea, it was decided that the only safe way was to bar Germans from all points of vantage.

German Wireless Officer Arrested in Rochester

THE Intelligence Department of the Army made a great catch when its agents landed Lieut. Ernest Adolph Buderus von Carlhausen in Rochester, N. Y., on February 16 last, after trailing him from New York. Some of the facts concerning this man's activities have been given out by the Rochester office of the Department of Justice.



Fitzpatrick in St. Louis Post-Dispatch

"This paper says Hindenburg is dead"
"Which one of the marines got him?"

The marines in France have lived up to the best traditions of valor in the service. The boys in Fitz's cartoon naturally conclude that their mates, if anybody, would have "got him"

The German, it appears, is a wireless expert, and while in Rochester attempted to purchase a tract of land on Irondequoit Bay, in a secluded location, with the intention of erecting thereon a powerful wireless plant from which messages might have been sent direct to Germany.

Carlhausen was employed at the Ritter Dental Manufacturing Company while in Rochester, and lived with a woman not his wife, according to information in the hands of the authorities. His wife was arrested shortly after Carlhausen himself was captured, the woman being found on Long Island. She is said to have made a record before the war as a diplomatic spy, and is believed to have succeeded in getting valuable papers into the hands of German agents. The theft of a code book of an American battleship was one of her most important coups. A naval officer was court-martialed for this.

Carlhausen was also receiving mail as Ernest A. Buderus. He is a graduuate of the naval college at Kiel, and is an electrical expert.

The German is now interned at Fort Oglethorpe, Ga.

Radio Frequency Changers

Reported Progress in Their Application to Wireless Telegraphic and Telephonic Communication

By E. E. Bucher

Director of Instruction, Marconi Institute

STUDENTS of radio telegraphy are familiar with use of frequency-multiplying transformers for increasing the frequency of a normally low-speed radio frequency alternator to a value suitable for transmission at commercial wave lengths. This system has not been widely adopted, in fact, prior to the war it had been employed in but one instance in the United State, viz., at the Telefunken Station, Sayville, L. I.

It is claimed by the inventors that this method of multiplying frequencies possesses certain inherent advantages over the radio frequency alternators of either the Alexanderson or the Goldschmidt reflector types, chief among them being the reduced initial expense of construction. In order to secure large power outputs from either of these machines a very expensive design is required. The high peripheral velocity of the rotor is another factor difficult to get around except at the lower frequencies.

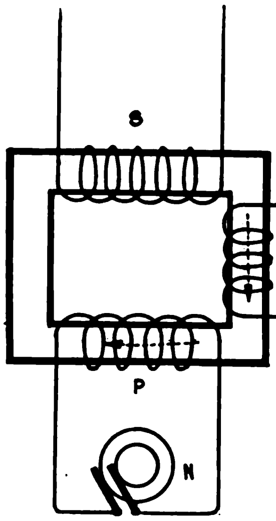


Figure 1—Diagram showing the fundamental principle of the frequency changer

In the frequency transforming system the alternator frequency lies between 5,000 and 15,000 cycles per second, which partially reduces the mechanical and electrical problems, particularly at frequencies exceeding, say, 75,000 cycles. Secondly, the length of the wave motion radiated by a radio frequency alternator is not readily changed, for it requires a change of armature speed and a consequent readjustment of the tuning circuits for electrical resonance with the aerial, the readjustments being more complicated with the Goldschmidt machine than with the Alexanderson alternator. Furthermore, the maximum output of the radio frequency dynamo is secured at some constant speed, which if changed to another speed to give another frequency, results in uneconomical operation. Other difficulties arise in the control of the antenna currents from such alternators for radio telegraphic and telephonic signaling. On the other hand, the frequency of the antenna currents in the frequency transformer system can be quite readily changed by the aid of special circuits here to be described. The iron and eddy current losses in the frequency transformer system, however, must be considerable, as is evidenced by the fact that oil and water cooling facilities are provided. Just what commercial application these frequency changers will have in the future is difficult to state, for we are required to rely on the statements of the inventors, solely, as regards their efficiency.

The fundamental principle of the multiplying frequency transformer system may be partially explained by aid of the diagram, figure 1, where P and S are the primary and secondary coils, respectively, of a radio frequency iron-core transformer, fed by, say, 10,000 cycles from an alternator N. A DC excitation winding A, fed by a battery or dynamo B brings the magnetism of the core to the "knee" of the characteristic saturation curve or to the point where an increase of current results in practically no increase in the magnetism.

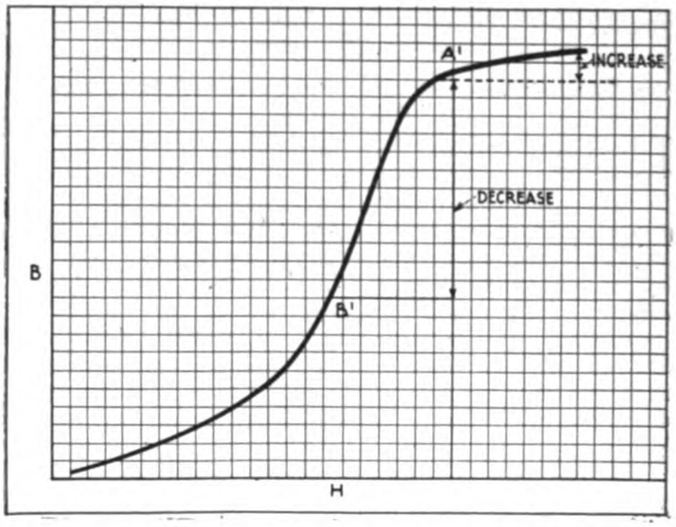


Figure 2—Characteristic B-H curve

Such a curve is shown in figure 2. This is commonly called the B-H curve where H represents the ampere turns of winding A and B the resulting magnetic flux through the core. Point A' is the "knee" of the curve.

Now in the circuit of figure 1 there is superposed on the flux set up by winding A, the flux induced in the coil by winding P (fed by the alternator) and when P sends its flux in the same general direction of that set up by winding A, it is evident from the curve that the total flux is but slightly increased. The resulting wave of magnetization is flat-topped and it, therefore, has practically no effect on the secondary winding S.

On the other hand, the reverse cycle from N opposes the flux from A, resulting in a considerable decrease, say to the point B' (on the curve) and the wave of magnetization becomes peaked, that is, there is a large decrease in magnetism through the core, which on the termination of the half cycle of current from P, returns to the normal value of magnetization.

This decrease and subsequent increase of the magnetism through the core induces two pulses of current in opposite directions through S; in other words, a **complete cycle of alternating current.** In summary, the first half-cycle from P has no effect on S and the second half cycle induces a complete cycle of current in S.

A transformer of the type described would have no practical value for only ½ cycle of the alternating current is employed, in other words, a DC pulsating current through P in the proper direction would have the same effect. However, if two transformers are employed, as in figure 3, both alternations of the complete cycle from the radio frequency alternator are utilized so that current of double frequency flows in the complete circuit of S.

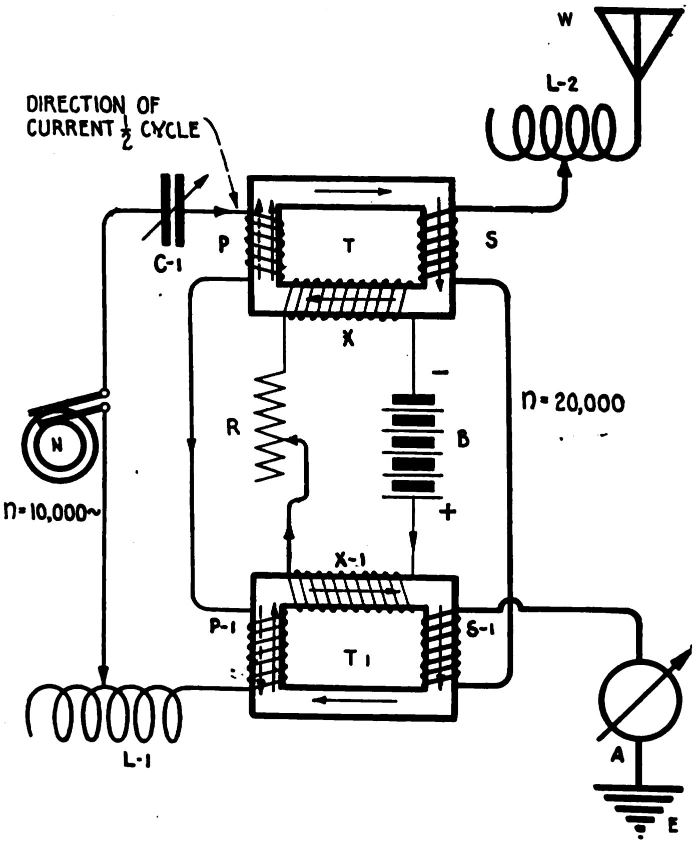


Figure 3—Circuit employing two transformers to produce current of double frequency

In the system shown in figure 3 the frequency of the 10,000 cycle alternator N is increased to 20,000 cycles in the antenna circuit corresponding to a wave length of 15,000 meters. T and T-1 are closed core transformers suitably designed for radio frequency currents. Primaries P and P-1 are wound in relative opposition. Secondaries S and S-1 are wound in the same direction. The transformers are saturated to the knee of the characteristic curve by windings X and X-1, which are also in relative opposition. B is a source of direct current, either a storage battery or DC dynamo, and R a regulating resistance. Choke coils (not shown) are connected in series with the DC leads to prevent the induction of radio frequency currents in the exciting circuit. One terminal of the winding S and one terminal of the winding S-1 are connected to the aerial and earth, respectively.

The circuit of the radio frequency alternator N is completed through the variable condenser C-1, primary windings P and P-1, through coil L-1. C-1 and L-1 tune the complete primary circuit to the frequency of the alternator.

Assume that the fluxes in the cores have the direction shown by the full line arrows, and moreover, for a half-cycle from the alternator the direction of the current is as indicated: the flux generated by winding P then has the same direction as the flux in the core of transformer T, and as a consequence, no induction takes place in S; but on the other hand, the flux generated in P-1 opposes the flux in the core of T-1, causing a complete reduction of flux and a subsequent rise to normal saturation. The result is the induction of a complete cycle of current in the winding S-1 for ½ cycle through P-1. For the next half cycle the process mentioned takes place in secondary coil of transformer T. Therefore, there will flow in the antenna circuit two cycles of current for each cycle through P and P-1; in other words, the frequency is doubled. Resonance as usual is established by the aerial tuning inductance L-2, and maximum antenna current is observed by the aerial ammeter A.

It is obvious that by an additional set of transformers connected to the terminals of S and S-1, the current of double frequency may again be doubled, but the efficiency of the apparatus decreases as the steps of transformation increase. A complete system for increasing the frequency by three steps is shown in figure 4.

The phenomena involved in the induction of currents in the circuit of figure 3 can be explained graphically by the series of curves in figure 3-A where graph O-1 represents the alternating current supplied by the radio frequency alternator N. In graph O-2, the dotted line represents the normal flux through the iron-cores set up by the DC excitation windings. The flat-topped portion of the curve B indicates the state of magnetism when the fluxes of the primary and excitation windings add up. On the other hand, the peaked portion of the graph shows the change of flux when the two fluxes in the core are in opposition.

The graph C shows the change of magnetization in the second transformer; it is to be noted that the peaks of B and C are separated by ½ cycle. The induction due to these peaks of magnetization is shown in graph D which is seen to be of double frequency.

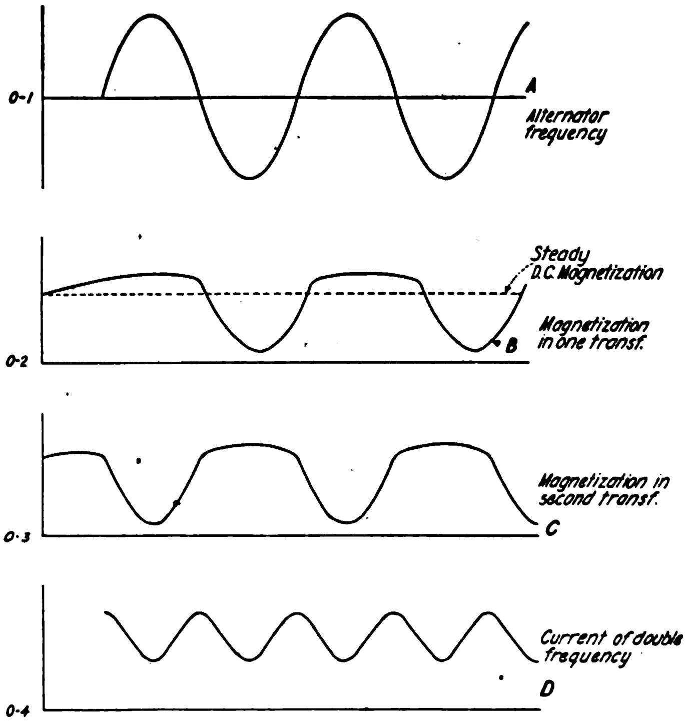


Figure 3A—Series of curves showing graphically the phenomena involved in the induction of currents by circuit in figure 3

Regarding the Design of the Frequency Transformers

Each transformer in a frequency changing group comprises an annular or rectangular closed arm yoke composed of thin laminated iron sheets so constructed that each sheet is seamless and has the form of the complete yoke. The thickness of the sheet decreases with increase of frequency.

The variation of flux generated by the alternator has a tendency to induce high voltages in the excitation windings fed by the DC dynamo, and in order to reduce these E. M. F.s to a safe value, it is of advantage in high power sets to divide the excitation coils into groups A, B, C, connected in parallel as shown in figure 5. A low voltage DC generator is then employed. If several frequency changers are used a single DC generator may be employed to excite all the windings.

It is found that the greatest efficiency is secured from these frequency changers when the effective number of ampere turns for the radio frequency winding is approximately equal to the ampere turns of the DC winding. The former should not exceed the latter by more than 20%. It tends toward increase of efficiency also to keep the magnetic leakage of the transformers at a minimum. The iron and copper losses must be reduced to the lowest possible value. The windings must be uniformly placed over the length of the yokes. In case very large power outputs are required the closed iron yokes should be constructed of individual insulated packs of sheet metal with intervening air spaces. The windings should also be arranged to give air space between the individual layers. The entire apparatus should then be submerged in oil circulated between the windings and the packs of sheet metals.

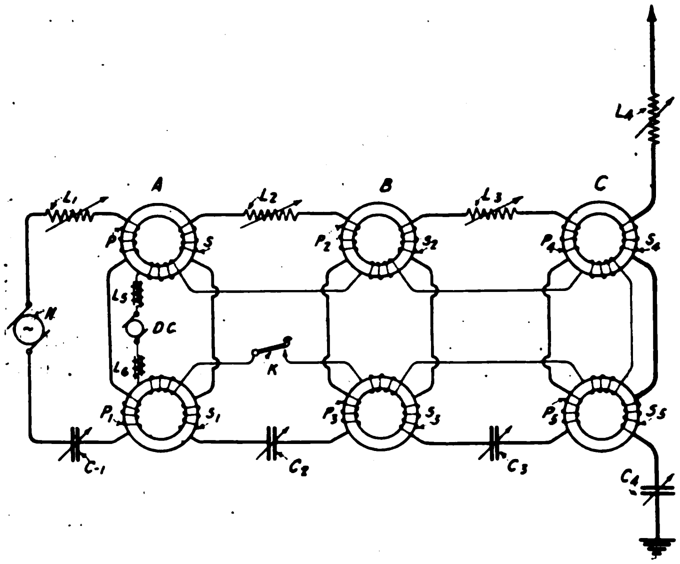


Figure 4—System for tripling the frequency of a radio frequency alternator

Three Step Multiplier

In the diagram of figure 4 the frequency of the alternator N is doubled by group A, doubled again by the group B and doubled once more by the group C; therefore if the frequency of N = 10,000 cycles per second, the frequency of the current in the antenna circuit will be 80,000 cycles, corresponding to the wave length of 3,750 meters Resonance in the antenna circuit is then established by the aerial inductances L-4 and variable condenser C-4. It is to be observed that a single DC generator excites the cores of groups A, B and C, and that signaling is accomplished by opening and closing the key K. The circuit between groups A and B is tuned by inductance L-2 and condenser C-2; and the circuit between groups B and C by the inductance L-3 and the condenser C-3. Careful adjustments must be made in this circuit for maximum efficiency.

Redoubling Transformer System

Von Arco and Meissner have recently shown modifications of figure 3, the objects of their design being to still further multiply the frequency, to modulate the antenna circuits at speech frequency for telephony, or to permit telegraphic signaling Special designs are offered to eliminate the induction of excessive high voltages in the various circuits. In fact, the inventors have encountered problems in the frequency transformer system equally as severe as other investigators have in respect to the high-speed radio frequency alternator, but step by step they have described various means for eliminating undesirable phenomena in the operation of the system.

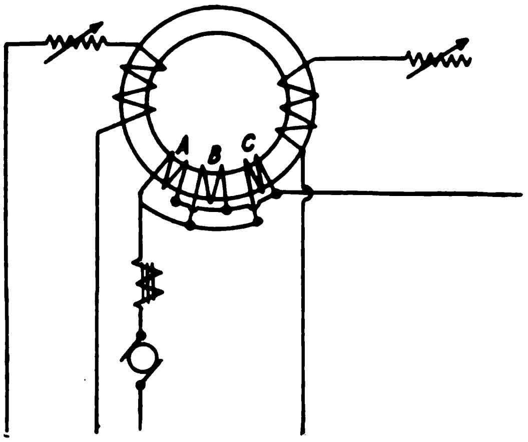


Figure 5—Showing method of reducing the production of high voltages in the excitation coils

A modified circuit in which the increase in frequency is obtained by superimposing the current from the secondary coils of a subsequent step upon the coils on a preceding step, is shown in figure 6. Through group A and group B there is induced in the coils S-4 and S-5 a frequency of four times the initial frequency, which is fed back through the conductor D, variable condenser C-1 and the inductance L-1 to the primary coils P and P-1 of the first step. This current is again doubled to eight times the initial frequency by group A and to sixteen times the initial frequency by the group B, the latter current flowing in the antenna circuit which has been carefully tuned to this frequency by the inductance L-4 and the condenser C-4. If the frequency of the alternator N is 10,000 cycles per second, the frequency of the antenna oscillation will

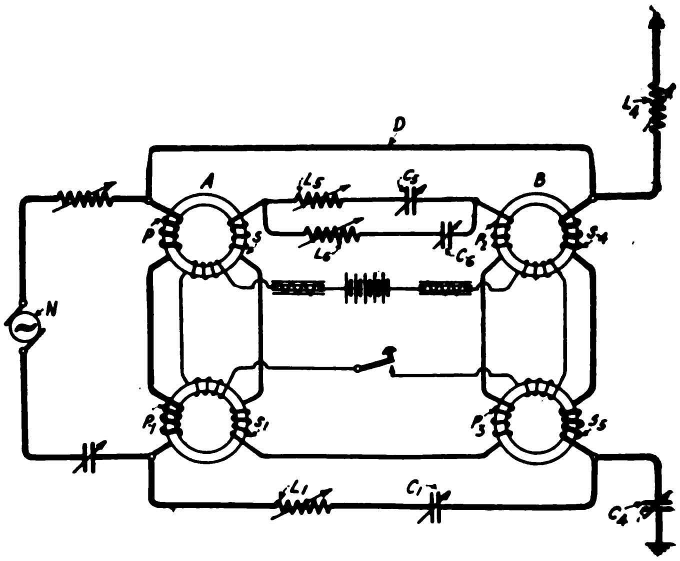


Figure 6—System for redoubling the frequency by superimposing the current of the last step upon the first step

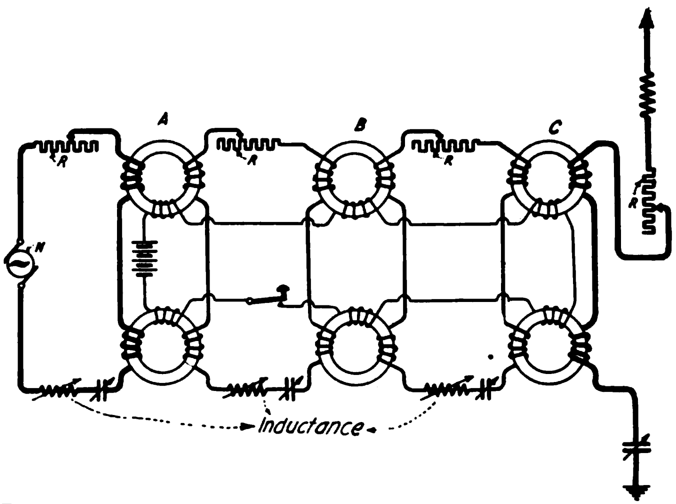


Figure 7—Diagram showing simple method of tuning the radio frequency changers

be 160,000 cycles per second, corresponding to the wave length of 1,875 meters. This brings the radiated wave down to a value suitable for transmission on the larger classes of vessels where large aerials can be erected.

It is evident that several paths must be provided for the currents induced in S and S-1 and that they must be carefully tuned to the various frequencies. Thus, inductance L-5 and condenser C-5 provide a path and act as tuning elements for the current of twice the fundamental frequency, and L-6, C-6 a path for the current of eight times the fundamental frequency. In all other respects the circuit is identical with figure 4.

Aperiodic Frequency Multipliers

Von Arco and Meissner have found through practical experience that the procedure of tuning the several circuits of cascade frequency multiplying systems such as shown in figures 4 and 5 becomes exceedingly tedious, for these circuits must be tuned to the impressed frequency of the alternator and any slight change in the frequency of the alternator will require a total readjustment of the circuits. The range of resonance is small and due to the extremely tight coupling between the various transformers, inductive disturbances arise which make it difficult to locate the resonance adjustment quickly. Again it is desirable in many stations to provide apparatus permitting the wave length to be quickly changed, but obviously if the transformer system has a multiplicity of tuning elements, it offers too many complications to permit this to be done quickly.

Two solutions of the problem have been given by the inventors whereby the problem of tuning becomes relatively simple. The circuits are shown diagrammatically in figure 7 and figure 8. In figure 7 adjustable resistances R have been placed in the generator, intermediate and antenna circuits to increase the damping. During the first adjustments to resonance, they are thrown in the circuit at full value and as the inductance and capacity are changed for resonance (as will be observed from the reading of the aerial ammeter), the resistances are gradually reduced until the maximum efficiency of conversion is secured. The foregoing process greatly assists the preliminary adjustments of the apparatus at any particular wave length, the circuit being first tuned roughly and finally more sharply.

In the system shown in figure 8 the tuning of all steps is eliminated except that of the antenna circuit, the intermediate circuit being adjusted for very high damping not by the insertion of resistance coils as in figure 7 but by giving the various windings a greater number of ampere turns so as to increase the damping. In the diagram A and B are two frequency transformers with the usual intermediate circuit, S-1, P-2, S-2 and P-3 and the excitation or magnetizing windings L. The antenna circuit is connected to the last set through the transformer M-1 with the adjustable secondary.

Owing to the high damping provided by these windings they act like ordinary transformers in which the phenomenon of resonance is not so evident. The resistance of the windings is comparatively large as is the self-inductance. The capacity of the condensers C, C-1 and C-2 is also very large to assist materially the damping factor.

Transformer M-2 is wound with a large number of turns to make the circuit of the generator nearly at aperiodic. The adjustable secondary of the transformer M-1 permits the E. M. F. in the antenna circuit to be adjusted to a safe value. If the frequency changer secondaries were supplied with variable secondary windings, the same results would be secured.

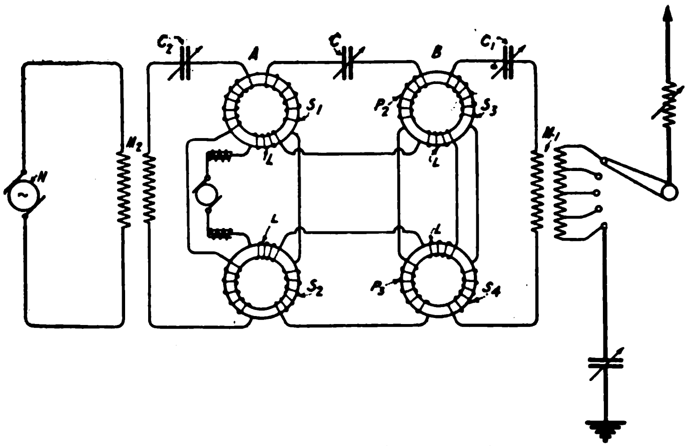


Figure 8—Aperiodic radio frequency changers

The inventors remark that the efficiency of conversion of this type of apparatus is comparatively good and at high powers the loss of energy due to the lack of resonance is negligible considered from a commercial view-point.

(*To be continued*)

December Wireless Age

Unique methods of controlling the antenna current for radio telegraphic and telephonic signaling are among the most recent developments in the art of wireless. The second instalment of "Radio Frequency Changers" in the December "Wireless Age" will therefore, be very timely.

When "Bunty Pulls the Strings" in a position back of the British lines a highly destructive shell screams over No Man's Land to return the Hate of Fritz. The photo on the left shows Bunty, a favored high calibered cannon of our Allied artillery

Above, in circle, are the chiefs of the headquarters Aviation Section with the American forces in Great Britain. Seated, Col. C. R. Day; standing, left to right, Lt. Col. W. H. Harms, Major W. A. Larned, Major W. H. Shutan

At the left, members of the Women's Signal Corps, composed of prominent Englishwomen, training in field buzzer and telephone communication

Mobility of equipment is equally as important as troop transport, so the caterpillar tractor goes forward on a speedier motor truck

Press Ill. Svce.

An actual scene on the first line with the battle raging across No-Man's Land. This is the view that the Signal Corps man gets as he maintains the lines of communication in the trenches

Under Fire With the Signal Corps

WHEN the average man hears the Signal Corps mentioned he has a somewhat hazy idea of its work and of how it is connected with the vast organization of the modern war machine. Even to the man in the army the Signal Corps is more or less an unknown quantity.

The activities of the Signal Corps are so wide in scope and their development of so recent a date that this vagueness is not to be wondered at. Until the time of the Civil War, armies and their units had been small enough to permit the commander to keep sufficiently in touch with his forces by runners and mounted messengers. During the Civil War, however, armies grew so large and unwieldy that their efficiency began to be impaired through lack of a perfect system of communication. It was seen that no matter how perfectly trained an army might be in its various activities, if it was unable to know the proper time to perform, its efficiency was imperilled. In fact, it was already realized that a perfect army is nothing more than a perfect soldier on a vast scale and, like that soldier, in order to be of any service or accomplish its aims, it must have a nerve and control system just as perfect as his.

The first step in improving the signal service was the use of the telegraph which, at the time of the Civil War, had been commercially perfected. While some progress was made at that time in its use, it was not until the time of the Spanish-American War that the signal service of the army was employed on anything like the scale of today. During that war the Signal Corps was an entirely mounted organization and was required not only to be as mobile as the cavalry but was even required to anticipate the needs of the cavalry and immediately have stations, where all officers could transmit messages, open and working as soon as the cavalry came to a halt. Our Signal Corps had developed a system of communication for open warfare that was practically perfect; in fact one which would have given any number of pointers to even the perfect German war machines.

At the opening of the present world war it was seen that the signal service as organized for open warfare would not be applicable to the different conditions required in trench warfare. As our entry into the war seemed so remote there was nothing done actually to change our methods, but at the same time the Signal Corps was making a study of the various means of communication in use by the different armies in Europe.

As soon as war was declared it was known at once just what the duties of the Signal Corps would be during the several months before the actual entry of our troops upon the firing line. It was known that the moment our force set foot on foreign soil to study and determine the method of warfare to be adopted it would be necessary to keep this force in constant communication with the authorities at Washington. As soon as it was decided that our operations would be in France the material and the personnel for laying trunk telephone and telegraph lines from the various seaports through the heart of France over to the theatre of operations were at once assembled, and this personnel was among the first actual troops to be sent over. Today there is scarcely a city in the principal part of France through which an American telephone line does not pass.

As soon as it was decided that we were to adopt the French methods of warfare we began to make a study of the French system of signaling. While we speak of having adopted the French system of warfare, this is

The Marines, too, have their signal units; here they are shown grouped above a telephone switchboard used at division headquarters

only approximately true as concerns the work of the Signal Corps. The main problems were to see what different kinds of messages had to be transmitted, the various ways the French had of doing it, whether any of the English methods were an improvement, and, lastly, whether we could not work out a system combining all the merits of the others, at the same time omitting their defects. This has been done so far as possible, and the United States Signal Corps now has a system of signaling as applied to trench and semi-open warfare which represents the most modern ideas of all the armies now at war, including even the German.

The success of this system is attested not only by the way in which it works in trench warfare but even more forcibly by the manner in which it has enabled perfect communication to be maintained in the first big offensive of the Americans.

In the dugout the quick-witted signalman is a valuable aid to the guns which are firing overhead

The lines of information from the various army headquarters are continued practically in the same manner as the main trunk lines that run through France in the service of supplies. Radio begins to play an important part in the game. However, it is within the division itself that the development of all means of communication takes place. Here every method of signaling that has ever stood up under the ordeal of battle plays its part. The whole area within ten miles of the front line is a maze of "lines of information." For convenience these lines may be divided into four great net works, any one of which may be depended upon as a complete and independent means of transmitting information.

The first and most complicated is the wire net. This begins at division headquarters and reaches its tentacles out toward the front in all directions. Its large central telephone exchanges located at intervals over the entire front, sometimes in half-demolished dwellings, sometimes in dugouts 40 to 50 feet deep, are the busiest spots on the battlefield. Its lines must furnish communication for the artillery, machine guns, the infantry, the trench mortars, the balloons, the engineers, the field hospitals, and all the other units that go to make up the war machine. In fact, the telephone system is much more elaborate and more complicated than in a young American city.

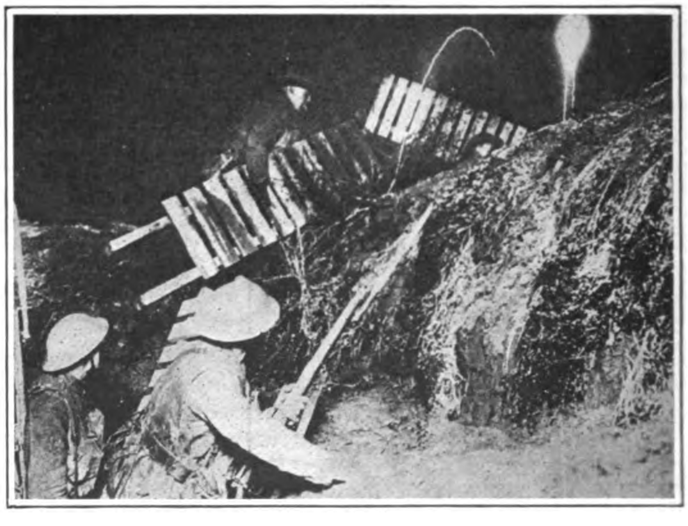
The problem of laying the wires under shellfire and keeping them in repair at all times is enormous. While the Field Signal Battalion of the Signal Corps is directly in charge of all systems of communication within the division it is assisted by telephone men from all the other units who work under it and carry out its ideas. The wires are often in the form of large buried lead cables, for whose installation it is necessary to employ highly specialized cable splicers, who carry on their work often with shrapnel raining around them. Lines radiate from these cables in smaller trunk lines, all of which have to be buried, but as these lines approach the front they are laid along the sides of the trenches the soldiers use.

It would be necessary to bury cables or wires fifteen to twenty feet to make them at all immune from shellfire, and as it is almost impossible to accomplish this, it can be seen how great are the troubles which the signal men encounter in trying to locate and repair breaks, especially in rain and snow or on dark nights, when the mere lighting of a match would be a welcome target for the enemy. All the wires have to be so carefully tagged and labeled that the telephone men can creep along a wire and merely by feeling these labels know exactly from what point the wire starts and where it terminates.

Another system which works independently of the wire system and which will interest the man who is inclined to wireless rather than wire work, is the radio net, which in itself furnishes complete lines of information throughout the area. In this net are employed radio instruments such as the average American radio man never dreamed of. Beginning at the front line are little radio sets with antennae so small that they can easily be concealed in a dugout. A little further back are trench radio sets whose transmitting range is larger than those in the dugouts, but whose antennae are so small that they can be placed just off the ground and not be seen by the enemy, or can even be placed in an unused communication trench.

The radio serves a great mission in the artillery, where it is relied upon as the fundamental means of communication between the artillery and the airplanes which see and control the fire of its guns. Each shot is observed by one or more airplanes, which at once send with their radio sending sets the exact information of the result of the shot to the radio receiving set back by the guns. In this way it is possible accurately to adjust the fire of the guns on a target, which without the use of the radio

(Continued on page 36)



When an advance is made the signalman goes over the top, too, for laying wires under shellfire is a routine part of his job

Code Practice for Receiving

The Principle, the Four Stages, and the Basic Law

By Gordon Lathrop

Of the Marconi Institute

IN last month's article the writer specified four stages of code sending, through which the code student must pass before he becomes expert in transmitting messages.

Phrased a little differently, though fundamentally identical, four stages may be defined through which the receiver must pass.

The first stage in sending finds the aspirant learning to construct each letter, numeral and punctuation mark in proper form.

The first stage in receiving is when the beginner is learning to detect, and write down, each letter, numeral, and the punctuation marks of common usage—to detect each, moreover, as a sound, an individual cadence.

The second stage in receiving is like the second stage in sending. This stage in sending has already been described as: "Learning to make a succession of letters to compose a dictionary word, code word or cipher combination in rhythmic steadiness." Applied to receiving, the second stage would be: Learning to detect and write down, accurately, and with comprehension of the word in its entirety, a succession of letters to compose a dictionary word, code word or cipher combination.

It is not enough to write down the letters blindly. Connection of the letters in word form should be made. That part of the brain which has to do with the registration of the cadence of each letter should be co-ordinating with those faculties which consciously recognize the word in its entirety.

Short, commonly used words, arranged in alphabetical relation, should be sent the beginner of this stage. Greater speed of transmission of words of increasing length may be gradually applied. Code words and cipher combinations may be included as part of the practice during this stage.

Building Up Endurance

The third stage in receiving, as is the third stage in sending, is that period during which the student is building up telegraphic endurance, so that he can last throughout the sustained periods which practical telegraphy calls for. Sentence practice should be added to word practice in this stage. Practice, practice, practice, aiming for accuracy and "clean" copy, rather than for speed, is the prescription for this stage.

The fourth stage in sending is when the aspirant puts on his sending the final touches which produce style and speed. In receiving, this stage finds the code man learning, in general, the tricks of the speedy telegrapher. Specifically, his aim should be to learn the forms of telegraphic communication which prevail in the particular branch of the art in which he desires to become a worker. Knowledge of the methods and forms, and of the phraseology employed in each of the branches of the telegraph field is essential to become an "all-round" expert telegrapher. Press, broker, commercial, railroad; radio in its increasingly numerous military and civil sub-divisions—each of these has its bag of tricks to be learned. Not until these become familiar can the telegrapher work at high speed in any particular branch.

Roughly, then, the four stages, in both receiving and sending, may be defined as (1)—The "A.B.C." stage; (2)—The word stage; (3)—The stage which makes for endurance, and (4)—The finishing-touches stage.

It should be noted that these four stages run into one another and are of indefinite lengths. What one student may acquire in telegraphic facility in one month may take another three months. Every telegrapher, however, must go through these four stages. Every one does, in fact, whether consciously or unconsciously; whether in proper sequence or haphazardly.

The Basic Law of Progress

A single principle rules throughout the four stages noted in the foregoing. The principle applies to receiving as well as sending, though perhaps not so obviously. It is self evident to even the novice in the code that the correct principle of sending is to keep the members which have to do with the process—the hand, wrist and forearm—in constant balance.

Even in such a physical process as sending, however, the hand, wrist and forearm will not keep in balance if the mind is not in harmony with telegraphic laws of progress.

"Progress in the order indicated by Stages 1, 2, 3 and 4," is the writer's conception of the basic law of correct progress in the code. "Do not pass from one stage to another until each has been thoroughly mastered in proper sequence," is its inevitably corollary. If an over-zealous student tries to whip an untrained hand and wrist into a speed which his desire wills, his sending will reflect the mental fault. He is out of balance, telegraphically.

The earnest endeavor of the student should be to resist the temptation to leap from one stage to another before he has thoroughly mastered each one in proper sequence. The practice of the code is peculiar in that one may experiment—after a fashion—and one is continually tempted to do it. The last stages of the art beckon invitingly to the novice immediately after he has learned the alphabet. But the student who tries for speed in sending before he has learned steadiness, is endangering materially his chances of ever becoming either a steady or a speedy sender. And he is not progressing. Time spent in trying to receive press matter, for instance, before he has learned to copy a succession of five-letter dictionary words with comprehension, is wasted.

The Acquisition of Balance

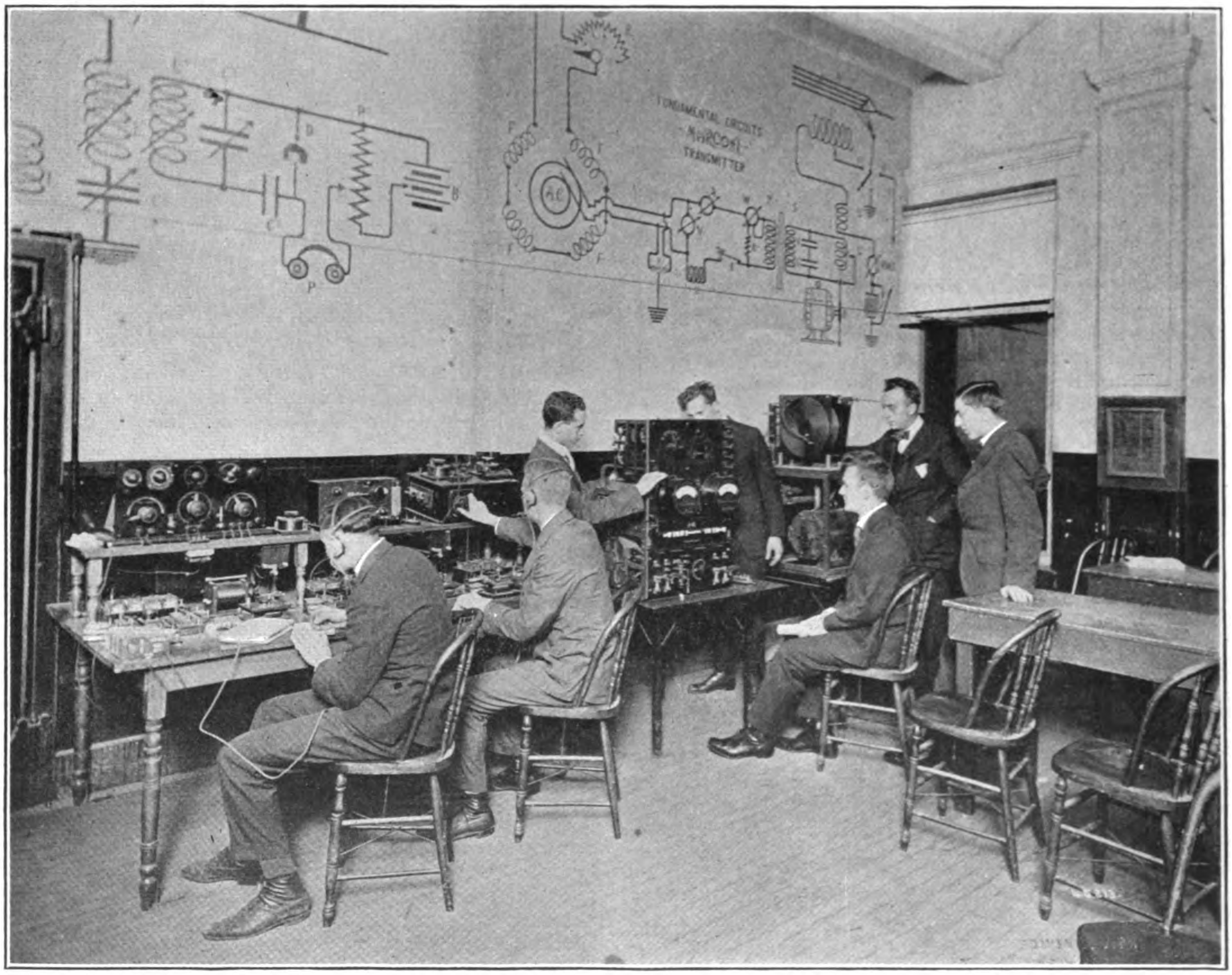
In applying to the receiving process the principle which is expressed in the one word "balance," the writer conceives the working of the mental apparatus in the same manner he would of a system of telegraphic machinery in proper relation and coordination. As a matter of fact, "in balance" is the term applied by technical men to such frictionless interworking of the telegraphic system. The whole will not balance if a part has been neglected. Moreover, the assembling of the apparatus must be done systematically.

The sequence of instruction given the beginner in telegraph receiving should likewise be systematic. Receiving is a process of taking on one conception after another; then of tucking them away—through the effort made by practice—in that part of the mind where are stored the things one knows so well they function without conscious effort. Not until the ideas of any particular stage function without conscious effort is the receiver "in balance" at that particular stage. The test of the student's right to progress from one stage to another should be whether he has learned to fulfill the requirements of each stage with a minimum of conscious effort.

In the first stage, there must be the correct conception of the letters "A" to "Z," for instance. Throughout all the intermediate stages, to the point where the radio man can detect cipher combinations through heavy interference, or to the point where the speedy press telegrapher, working with Phillips Code, will associate, for example, the letters "az," as sent, with the word "applause," the process of receiving is one of taking on and tucking away a sequence of correct conceptions.

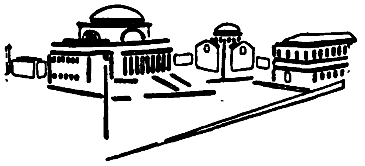
The duty of the code instructor, as the writer sees it, is to render the student's progress as free as possible of needless handicaps. Further, the instructor should lay out a system of practice material. It is the writer's opinion, based upon experience and demonstration, that this system should be built around the principle laid down in the foregoing; governed by the law of the code as stated, and its corollary, and arranged in recognition of the four stages of progress which have been specified.

In next month's article the writer will present an arrangement of exercises which he believes will help the beginning telegrapher as much as any prepared system can help. Primarily, in code as in everything else, the burden of achievement rests upon the individual.



Instruction in the adjustment of wireless receiving apparatus is given in the Marconi Institute during the period in which the students are perfecting their skill in receiving the code messages. In the photograph above members of an advanced group are shown operating various types of receiving apparatus, the nature of war service in which they will soon engage requiring familiarity with marine sets of varying powers from battleship equipment to submarine and Signal Corps apparatus for land and airplane use.

Progress In Radio Science



Marconi's Improved Radio Transmitter

READERS of THE WIRELESS AGE are already familiar with the apparatus developed by G. Marconi for the production of continuous oscillations by over-lapping wave trains. This system has proved most effective for long distance communication at high power. It has done away with many of the intricate mechanical and electrical problems encountered in the construction of radio frequency alternators or arc transmitter system. Moreover it makes an apparatus capable of generating damped oscillation at any spark frequency desired.

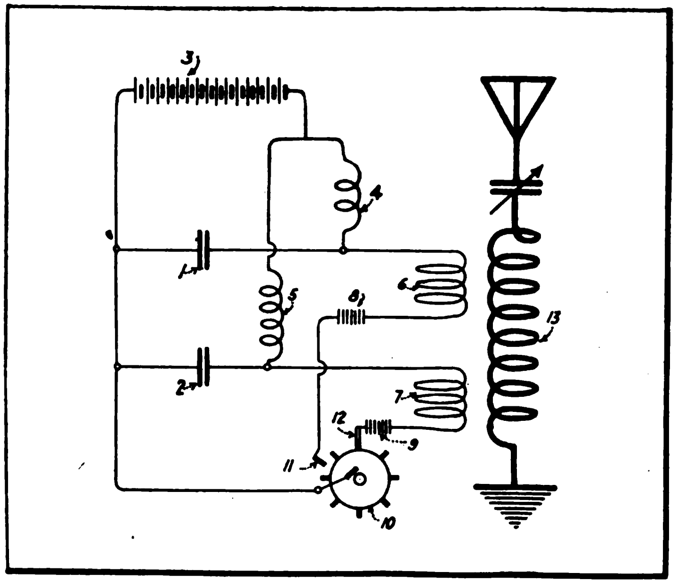


Figure 1—Circuit showing improved method of producing continuous oscillations by overlapping wave trains

In this system a number of spark discharges are made to occur successively in such a way, that the resulting trains of oscillations induced in the antenna circuit, overlap in synchronism. This results in the flow in the aerial circuit of oscillations of constant amplitude.

Numerous circuits have been devised by Marconi to carry out this fundamental idea, among which those shown in figures 1, 2 and 3 stand out prominently. The apparatus shown in figures 2 and 3 are modifications of figure 1.

In these diagrams, 1 and 2 are two high voltage condensers which are charged from the same source of current 3 (usually a direct current dynamo or a large storage battery), to inductance 4 and 5 respectively. These condensers discharge through primary coils 6, 7, the quenching spark discharges 8 and 9 and a disc discharger 10.

The electrodes 11 and 12 belonging to the condenser circuits 1, 6, 8 and 2, 7, 9 respectively are so arranged that discharges take place from 11 and 12 to the disc studs alternately at regular intervals and the interval between the commencement of the discharge of one condenser and the commencement of the discharge of the next condenser should be equal to or an exact multiple of the period of the aerial and intermediate closed circuit assuming that 6 and 7 are wound in the same way; if, however, they are wound in the opposite way, the interval should be equal to or an odd multiple of the half period. The primary coils 6 and 7 are coupled to a common secondary 13 which forms part of an aerial circuit.

The inductances 4, 5 should be large compared with inductances of the other parts of the circuits, but should, of course, not be so large as to prevent the condensers being sufficiently charged in the time available.

Figure 2 shows a modification in which a single inductance 14 through which both condensers discharge is employed, instead of the two separate inductances 6 and 7. This inductance is not coupled directly to the aerial but to an intermediate oscillating circuit 141 which is itself coupled to the aerial.

Figure 3 shows a modification in which each discharge circuit includes a spark gap which is of such nature that the normal working potential will not spark but which is capable of being ionized by a second or trigger spark, which by reason of the shortness of its wave length and also because its circuit has little interaction with other circuits gives more accurate timing than is possible with the dischargers in the main circuits.

The main condensers 1 and 2, which are charged from the high tension battery 3 or other source of supply through inductances 4 and 5, discharge through primary coils 6 and 7, quenching arrangements 8 and 9, the secondaries 15 and 16 of two small oscillation transformers and electrodes 11 and 12, respectively, to the main disc 10.

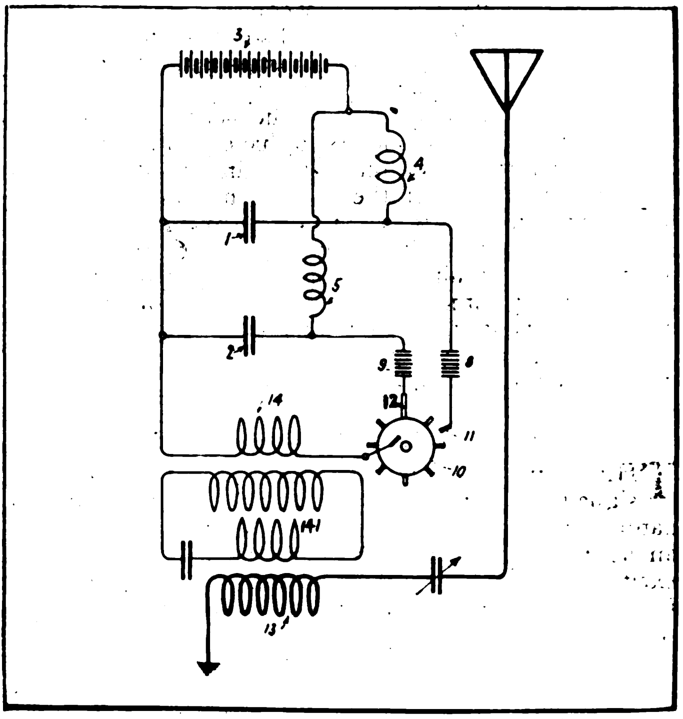


Figure 2—Modified circuit of figure 1

Auxiliary or trigger condensers 17 and 18, which are small in comparison with 1 and 2, are charged through suitable inductances 19 and 20 from a high tension battery 21 or other source of supply. These condensers discharge through the primaries 22 and 23 of the small oscillation transformers, and electrodes 24 and 25, respectively, to a trigger disc 26.

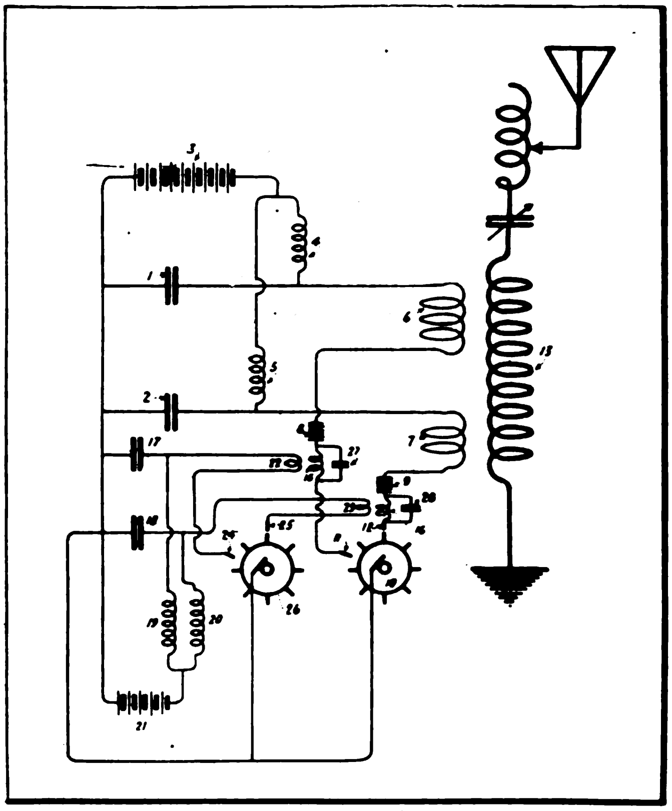


Figure 3—Showing the use of a trigger spark

This trigger disc is preferably coupled to the main disc 10 and the electrodes are arranged so that when a stud on 10 is opposite 11 or 12 a stud on 26 is opposite 24 or 25, respectively. The main circuits 1, 6, 15 and 2, 7, 16 are both coupled and tuned to the aerial circuit. The trigger circuits 17, 22 and 18, 23 have preferably a very much higher frequency than the main circuits; the secondaries 15 and 16 of the oscillation transformers are preferably shunted by small condensers 27, 28 placed across them and the circuits 15, 27 and 16, 28 are tuned to the trigger circuits 17, 22 and 18, 23, respectively.

Immediately either condenser 17 or 18 discharges, a high potential is induced in the oscillation transformer secondary 15 or 16 causing a spark at 11 or 12 thus allowing the main condenser 1 or 2 to discharge.

A Novel Radio Telegraph Aerial

THE ordinary receiving aerial responds best to radio signals, the frequency of which coincides with its natural frequency. It has also been observed that such an aerial system will oscillate at its own period when excited by electro-magnetic waves having a widely different period. This is particularly true when such electro-magnetic waves emanate from nearby powerful transmitters or are the result of atmospheric electricity.

Roy A. Weagant, chief engineer of the American Marconi Company, has made an exhaustive investigation of this phenomenon and he believes it to be due to the distributed capacity, inductance, and resistance of the aerial. He has found that by placing a series of coils in the antenna from the earth to the free end, the aerial takes on a characteristic which permits it to respond only to radio signals of the frequency to which the complete antenna system is tuned.

By adopting this construction he was enabled to eliminate the interference of transmitting stations operating on short wave lengths located in proximity to the large receiving aerial employed by the Marconi Company in transoceanic communication.

The fundamental construction is illustrated in figure 1, and a modification in figure 2. In figure 1 a series of inductance coils i, preferably of equal dimensions, and placed at substantially equal distances apart, are inserted in the antenna system. The usual receiving transformer is indicated by the primary coil 10 and the secondary coil 11. The presence of the coils i in the receiving antenna impart to it a fundamental oscillating characteristic, which blocks out oscillations of higher frequency than those which it is intended to receive.

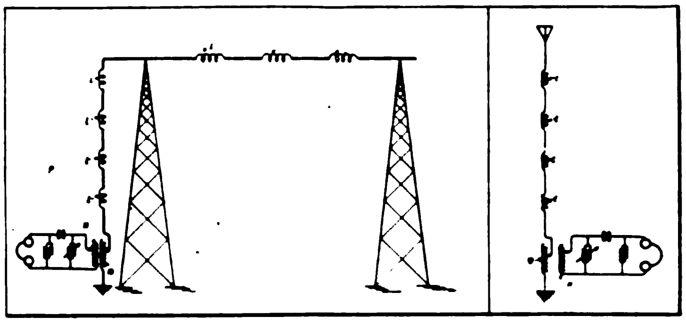


Figure 1 (right)—Showing new type of aerial with series of coils inserted
Figure 2 (left)—A modification of figure 1

In the ordinary aerial system, the antenna can be set into oscillation at its own natural period, either by the repeated application of minute impulses at the frequency of the antenna, or by shock excitation such as might be caused by one or more uni-directional impulses or oscillatory impulses of relatively great strength, but at a frequency differing from that of the natural frequency of the antenna.

Mr. Weagant declares the construction as in figure 1 to be so effective in this respect, that it became possible at the Marconi factory in Aldene, N. J., to receive signals transmitted direct from Nauen, Germany, with the ordinary factory antenna while the operation of testing transmitters in the factory building was going on. The inventor mentions that this aerial is most effective in the reception of continuous oscillations.

Method for Exhausting Vacuum Tubes

AS mentioned in previous articles it is highly desirable that the anode of a three-electrode vacuum tube be heated during the exhaustion process to free it of all occluded gases.

In the construction of vacuum tubes in which it is desired to maintain a high vacuum, it has been found that unless the electrodes and walls of the vessel have been subjected to a vigorous preliminary treatment, the gases retained by them will slowly leak out with the result that the vacuum is soon decreased and ionization by collision with the gas molecules can then take place.

This preliminary treatment is usually carried out by heating the walls of the vessel externally, and by directing a stream of electrons towards the anode or plate. These electrons upon striking the anode liberate all ionizable matter which may be removed in the pumping process.

To do this effectively it is essential that the energy of the striking electrons shall exceed their velocity during normal operation of the vacuum tubes.

An apparatus has recently been devised by Ellsworth Buckley, which provides for heating the anode by vigorous bombardment of electrons without endangering the cathode (or filament), this being the method by which gases are driven from the plate.

It has been found that in preparing vacuum tubes it is not allowable to draw from the cathode a much larger current than is used in normal operation, for the effect of that treatment is to disintegrate the cathode. The present invention insures that the electrons striking the anode shall do so under the influence of a large voltage and consequently with large kinetic energy, while at the same time this large voltage is not able to draw more than normal current from the cathode.

In a thermionic device of the type described, if the potential of the auxiliary electrode is made negative with respect to the cathode a larger voltage between anode and cathode is necessary to produce the same current from the cathode as would appear in the absence of such a voltage applied to the auxiliary electrode. But the kinetic energy of the electrons striking the anode increases with increased voltage, and it is therefore possible by applying a negative potential to the auxiliary electrode, to increase the voltage effective in driving electrons to the anode very much above the normal value, while maintaining the current at its normal value. By this process vigorous bombardment of the anode is possible without drawing more than normal current from the cathode.

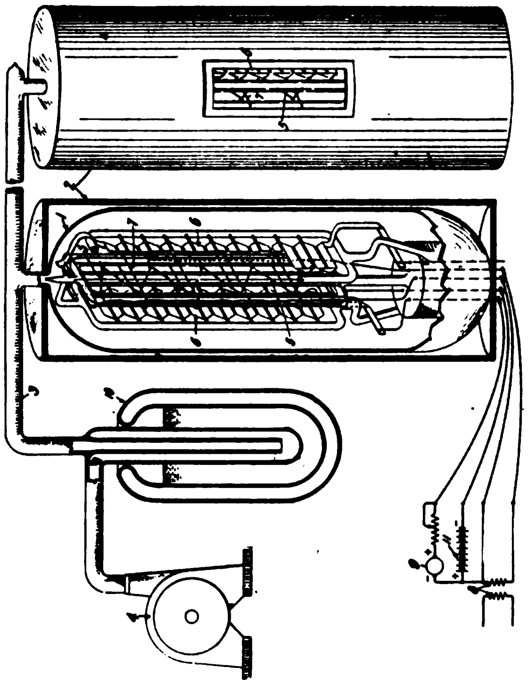


Figure 1—Showing apparatus used in Buckley's method of exhausting vacuum tubes

Buckley's process will be more completely understood in connection with the drawing figure 1, in which 1 represents a vacuum tube of the usual type consisting of an evacuated vessel containing cathode 5, anode 6 and an auxiliary electrode 7. This vessel is inclosed in an oven 2 which may be heated externally. The glass tubing 3 serves to connect the tube with a molecular pump 4 or other suitable means for exhausting it. The liquid air-trap 10 is included in this line of tubing for the usual purpose. The filament 5 is heated by means of alternating current furnished to it through the medium of the transformer 8, whose primary winding is energized by means of the source of alternating current, not shown in the drawing. The voltage between anode and cathode is supplied by means of the direct current generator 9, while the electromotive force required to maintain the auxiliary electrode negative with respect to the cathode is obtained from the battery 11, whose negative pole is connected to the auxiliary electrode.

During the process of evacuation the pump is operated, the filament heated and a discharge started between anode and cathode. The battery 11 is then applied and the voltage of the generator 9 increased. The current through the tube is adjusted to approximately normal value and the bombardment of the anode at the increased voltage is continued until no evidence of gaseous ionization in the tube can be detected.

As an example of the voltages employed in one type of tube, it has been found that in the early part of the process a maximum of about 200 volts can be maintained between the cathode and the anode. By applying 110 volts between the cathode and the auxiliary electrode making the latter negative, a maximum of 500 volts or more may be obtained with consequent more rapid release of gas from the anode. In the later stages of exhaust a potential difference of 750 volts or more may be maintained by the use of the negative auxiliary electrode, while if that electrode were disconnected it would not be more than 550 volts.

A Combination Circuit for Tube and Crystal

THE English Marconi Company has developed a novel circuit for the combined or individual use of the vacuum tube and the crystal rectifier. The scheme of connections is shown in figure 1. C is short wave condenser, L is the antenna inductance, L-1 a coil which acts as a primary winding of a receiver tuner for use with the crystal detector D, or as a regenerative coupler for amplification by the vacuum tube. L-2 is the secondary of the tuning transformer for use with the crystal or a tuning element of the plate circuit for regenerative coupling in connection with the vacuum tube. C-1 is the plate circuit tuning condenser. D is a carborundum rectifier, P-1 a potentiometer, B-2 the plate battery, T a telephone transformer and P-2 a pair of low resistance telephones.

It will be clear, from close observation of the diagram, that if the filament F of the vacuum tube is cold, the crystal detector D alone may be employed to detect spark signals. L-1 is then the primary of the tuning transformer and L-2 the secondary. If, on the other hand, amplification of the incoming signal is desired, the filament F is brought into play. The grid element G is then connected to the antenna inductance L and by suitable adjustment of the reaction L-1, L-2 and of the grid circuit potentiometer P-3 the circuits of the tube will be set into self-oscillation. The apparatus then receives by the phenomenon of beats or by careful adjustment of L-1 and L-2. Amplification of the incoming signal can be secured without the beat phenomenon.

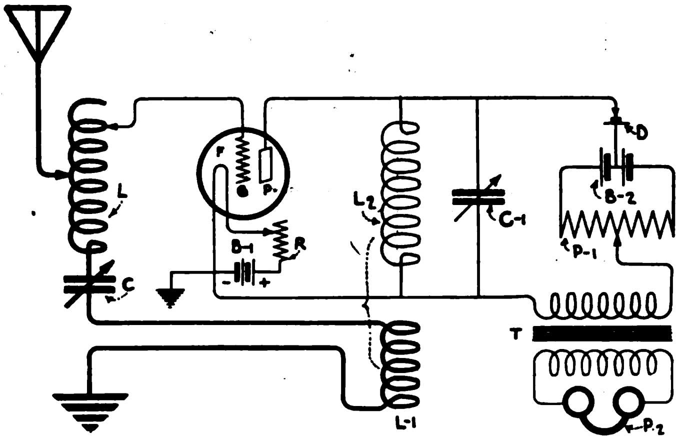
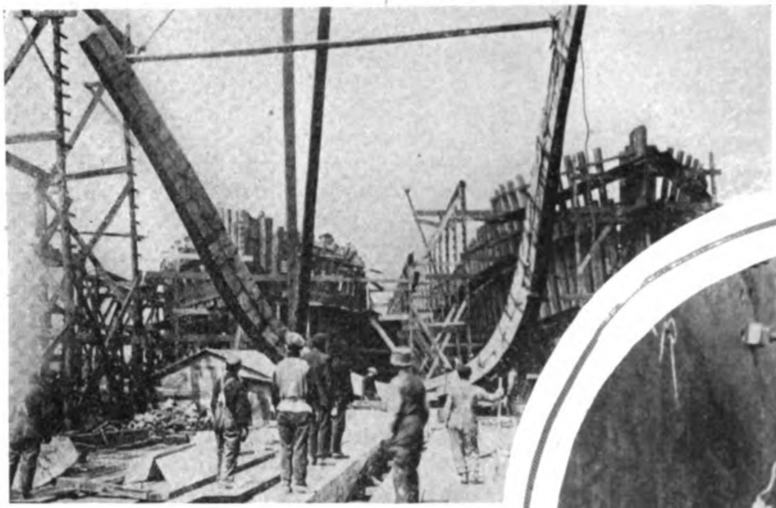


Figure 1—Circuit for the combined or individual use of vacuum tube and crystal rectifier

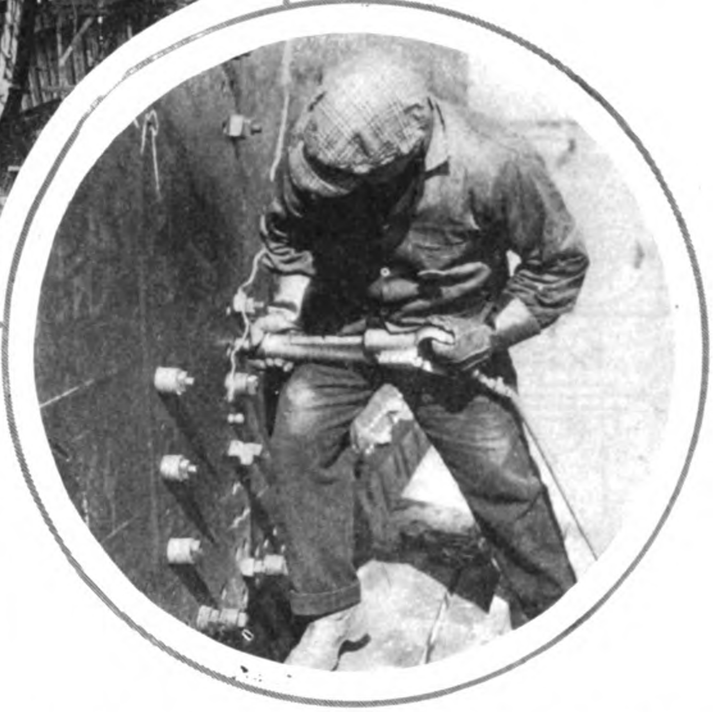
There is thus provided a receiving apparatus which is independent of the vacuum tube, for should it become inoperative, such as by burning out of the filament, signals can still be received by the crystal detector alone. For longer distances, the vacuum tube circuits are brought into action for amplification. The apparatus clearly is responsive to undamped waves as well as damped waves.

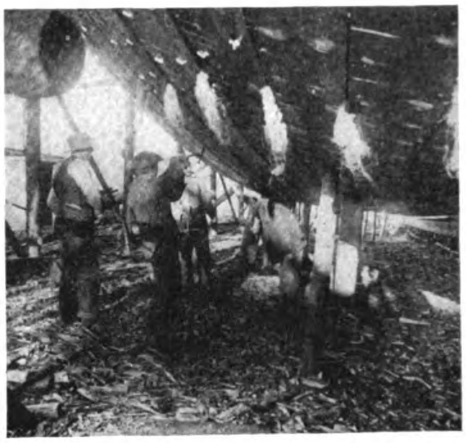
Photos: Underwood & Underwood

Building Ships for Uncle Sam



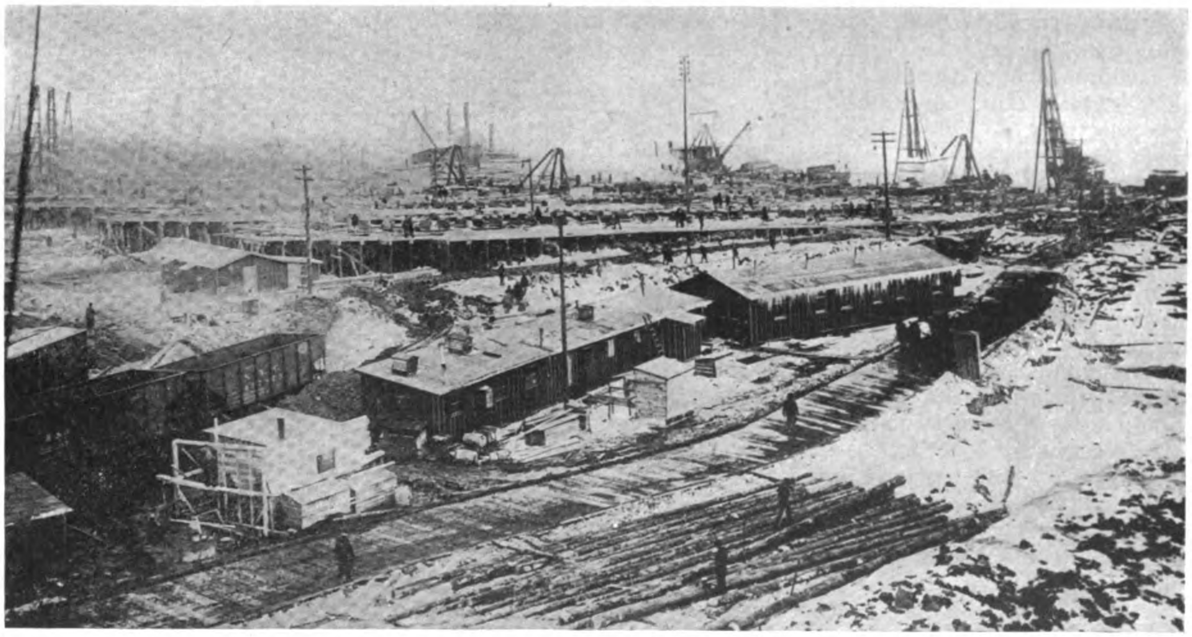
To the left, a shipyard scene as the first frame or rib of one of the standardized wooden vessels is raised in view of two partially completed sister ships





Above, in circle, one of the riveters with his electric machine endeavoring to maintain the high speed of his crew, record breaking which has astonished the world being a daily occurrence with these loyal workers

To the left, an underneath view of the belly of a wooden ship showing the calking of her seams in progress. So well are these wooden vessels constructed that Lloyds' give them an insurance rating as high as steel craft



A glimpse of the famed Hog Island shipyard, the largest in the world, though but 9 months old

Wartime Wireless Instruction

A Practical Course for Radio Operators

By Elmer E. Bucher

Director of Instruction, Marconi Institute

PART II—ARTICLE I

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EDITOR'S NOTE—Part 1 of this series of lessons began in the May, 1917, issue of THE WIRELESS AGE. Successive installments were devoted to the fundamental actions of radio transmitting and receiving apparatus for the production and reception of damped oscillations.

Part 2, the present series, will deal with undamped wave generators, including bulb transmitters and receivers for the reception of undamped oscillations. The direction finder and other special appliances employed in radio telegraph work will be treated fundamentally. A discussion of the basic principles of wireless telephony will terminate the series.

The outstanding feature of the lessons has been the absence of cumbersome detail. The course will contain only the essentials required to obtain a government *first grade commercial license certificate* and to supply the knowledge necessary to become a first rate *radio mechanic.*

CONTINUOUS WAVE GENERATORS
DECREMENT AND TUNING

(1) The apparatus heretofore described in this series of lessons dealt with the transmission and reception of radio telegraph signals by means of damped oscillations. In the systems under consideration, these oscillations were produced principally by the **periodic discharge of a condenser through an inductance across a spark gap.**

(2) To insure selectivity, that is, discrimination between stations operating on nearly the same wave lengths, it is desirable that the **oscillations** in a wave train be **slowly damped out,** that is, the rate of decay must be reduced to a minimum.

(3) The United States Laws decree that the minimum damping of two successive oscillations must be .2 or less; that is, **the logarithm of the ratio of the amplitude of one oscillation to the next oscillation in a wave train must be .2 or less.**

(4) It has been shown that if the damping decrement of a wave train is known, the number of oscillations per wave train (assuming they have died out when amplitude of the last one is .01 of the first one) can be obtained from the following formula:

$$M = \frac{4.605 + \delta}{\delta}$$

where δ = the logarithmic decrement.

Thus a decrement of .2 corresponds to approximately 24 complete cycles in the antenna current for each spark discharge and similarly a decrement of .01 to 46 complete cycles.

(5) Modern wireless telegraph transmitters radiate wave trains the decrement of which is often as low as .03 per cycle corresponding to 150 or more oscillations in the aerial circuit for each spark discharge in the closed circuit.

(6) **When the decrement of a transmitter is low a slight change of inductance or capacity at the receiving station will eliminate the signals.** The factor of selectivity is accordingly high. On the other hand, **if the decrement is high, a relatively large change of inductance or capacity is required at the receiver to eliminate the signals.** The factor of selectivity is accordingly small.

(7) The desired low damping of the aerial currents in a radio transmitter is secured by the employment of a spark gap giving good **quenching** effects. The reaction of the aerial circuit on the spark gap circuit during the building up of the aerial oscillations is thereby prevented, permitting the aerial currents to decay at the natural damping of the antenna circuit. The insertion of loading coils at the base of the aerial aids in lowering the decrement.

(8) The sharpness of tuning or the adjustment for resonance in two coupled circuits is limited by the sum of two decrements, that of the impressed E.M.F. and that of the circuit being driven. The same applies to a radio transmitter and receiver. Hence it is obvious that a **transmitter employing undamped or continuous oscillations gives greater selectivity** than the damped system, for it is evident that the undamped or continuous oscillations possess no decrement. (Slight inequalities of amplitude exist in most continuous wave generators.)

(9) One of the great advantages of the continuous wave generator in radio telegraphy is the **syntonic** or **resonance** effects secured at the receiver, and, moreover, owing to the new principles of reception which such transmitters bring into play, the range of transmission has been remarkably increased.

(10) It should be known here that previous to the advent of the **vacuum tube generator** for continuous waves, a reliable short wave continuous oscillation generator was not available. The most commonly used undamped oscillation generator heretofore was the **arc generator,** which will not function uniformly at wave lengths below 1000 meters, the best results being obtained at frequencies corresponding to wave lengths above 3000 meters. The vacuum tube generators, on the other hand, will function at frequencies from a **cycle per second up to several millions.**

PROBLEMS INVOLVED IN THE RECEPTION OF CONTINUOUS AND DISCONTINUOUS WAVES

(1) It is frequently of advantage to make a comparison of the continuous and discontinuous wave system in respect to the methods of reception.

(2) Since the **telephone** is almost universally used to record radio telegraph signals, it is convenient to consider the problems of reception from the standpoint of this piece of apparatus. It has been established that a **current which impulses the diaphragm of the telephone receiver from 100 to 1000 times per second gives the maximum response, with a given current.**

(3) In the discontinuous wave transmitter the currents induced in the receiving apparatus are already modulated at an **audio frequency** by the charging current at the transmitter, but it is plainly evident the energy radiated by a continuous wave generator will produce no effect on the receiving telephone because, for example, if a rectifier is connected in the receiving circuits the telephone diaphragm will be impulsed by direct current pulses occurring at radio frequencies.

(4) **Radio frequency currents in excess of 20,000 per second will not give audible response in a telephone, but a rectified radio frequency current if broken into groups of say 200 to 1000 per second will give audible response with a minimum of current.**

(5) In the case of the reception of undamped oscillation, we are compelled to break up the incoming currents at the receiving station into audio frequency groups either by **mechanical** or other means.

(6) The **tikker** and the **slipping contact detector** are simple circuit interrupters arranged to vary the incoming currents at the receiving station at audio frequencies. The **tone wheel** is a form of tikker which is in reality a partial rectifier producing audio frequency telephone currents. The **beat receiver** produces audio frequencies by the interference of two radio frequency currents, one of which is generated locally and the other, the incoming signal.

When this method of reception is combined with the amplifying properties of the vacuum tube enormous distances of transmission are possible

TYPES OF CONTINUOUS WAVE GENERATORS

(1) The most commonly used type of continuous wave makers are:

1—The Poulsen Arc generator.
2—The Vacuum Tube generator (sometimes called the bulb transmitter).

The other types are:

1—Alexanderson Radio Frequency Alternator.
2—Goldschmidt's Radio Frequency Alternator.
3—The Multiple Frequency Transformer system.
4—The Over-lapping Wave Train system (Marconi System.)

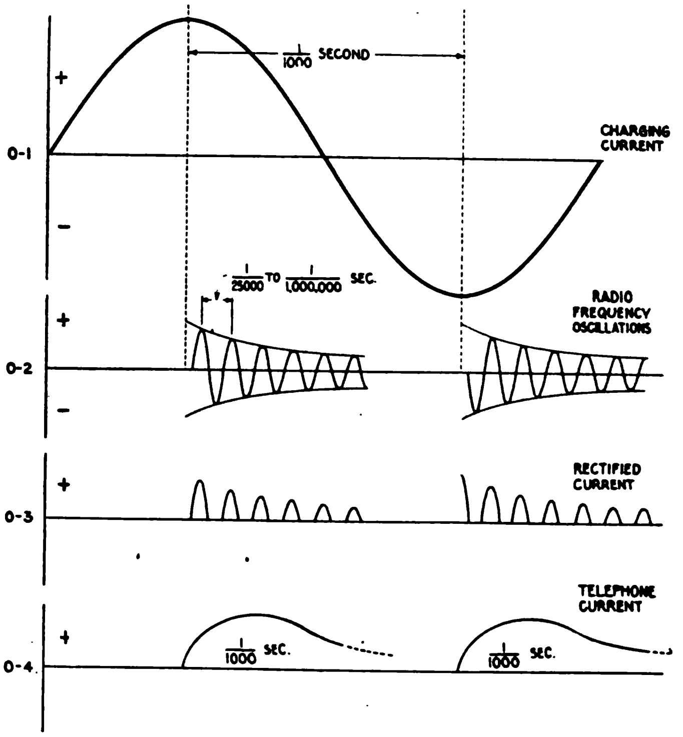

Figure 181

OBJECT OF THE DIAGRAM

To show graphically the fundamental principles involved in the transmission and reception of wireless telegraph signals by means of apparatus for the production of damped oscillations.

DESCRIPTION OF THE GRAPHS

Graph O-1 shows the audio frequency charging current applied to the high voltage condenser in the closed oscillation circuit of the transmitter; graph O-2 the resulting radio frequency currents induced into the antenna circuit of the transmitter which also may be taken to indicate the currents impressed across the oscillation detector (crystal rectifier) at the receiver; graph O-3 the rectified currents in the receiving circuits, and graph O-4 the approximate telephone current.

OPERATION

The frequency of the condenser charging current at the transmitter is assumed to be 500 cycles per second, and since in a **synchronous gap transmitter the condenser is charged and discharged once for each alternation of the charging current,** the spark frequency will be 1000 per second.

Each discharge at the spark gap will induce in the antenna circuit a **group of radio frequency currents,** such as shown in graph O-2. It should be noted that the time period of one alternation of the charging current is 1/1000 of a second, whereas the time period of a complete cycle of the resulting radio frequency currents may vary in commercial practice from 1/25000 to 1/1000000 of a second, depending inversely upon the square root of the product of the inductance and the capacity of the circuit.

Currents of the same frequency will be impressed across the oscillation detector at the receiver, where they are rectified, giving (assuming perfect rectification) the uni-directional pulses shown in the graph O-3. **These pulses occur at rates above audibility** (for it must be remembered that the telephone will not give audible response to radio frequency currents), but since they have the same general direction the telephone diaphragm responds to an average effect as shown in the graph O-4.

SPECIAL REMARKS

(1) It is evident from the foregoing that a 500 cycle synchronous transmitter will give 1000 spark discharges, per second and **each spark discharge will induce in the transmitting**

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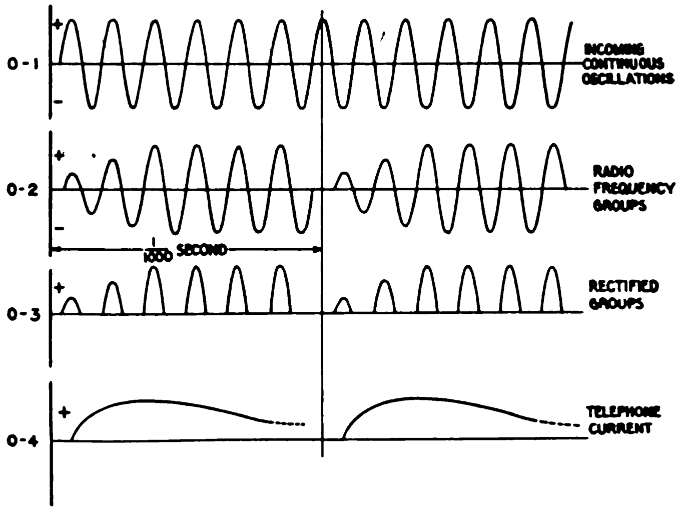

Figure 182

OBJECT OF THE DIAGRAM

To show the problems involved in the reception of continuous oscillations such as may be generated, for example, by a radio frequency alternator, and to offer a comparison of the continuous wave system with the discontinuous wave system.

PRINCIPLE

Because the wave motion radiated by a continuous or undamped wave transmitter is not broken into groups, as in the discontinuous or damped wave wireless system, it becomes necessary to interrupt the incoming currents at the receiving station at audio frequencies in order to secure the maximum of response from a telephone diaphragm with a minimum of current.

DESCRIPTION OF THE DRAWING

Graph O-1 shows a **train of incoming continuous oscillations** such as flow through the receiving circuits of an undamped wave receiver. Graph O-2 indicates the **resulting groups of radio frequency currents** when the incoming currents are interrupted mechanically, such as by use of the well-known tikker. Graph O-3 shows the **rectified groups of radio frequency currents** resulting if a rectifier is employed in connection with the tikker, and **graph O-4** the **resulting telephone current.**

SPECIAL REMARKS

(1) The graphs indicate only the results secured by the combined use of the tikker and crystal rectifier, but somewhat similar effects are obtained from the beat receiver (heterodyne or beat system, as it is sometimes called), to be described further on.

(2) It is to be noted that the telephone current is approximately the same in the graphs in Figures 181 and 182.

(Continued from first column)

aerial a group of radio frequency currents. Each group will radiate a **train of waves.** A 500 cycle transmitter will, therefore, radiate into space 1000 of wave trains.

(2) Following the actions to the receiver, it is seen that each spark discharge at the transmitter eventually sends a **pulse of direct current through the receiver.** Therefore, 1000 sparks at the transmitter will deflect the diaphragm of the receiver telephone 1000 times and **the pitch of the note emitted by the telephone diaphragm** will be substantially the same as that of the spark discharge at the transmitter.

(3) This accounts for the use of 500 cycle currents in spark radio telegraphy, for they impulse the telephone diaphragm at such rates as to cause it to emit musical sounds.

Two advantages are derived in the use of high spark frequencies:

(a) The telephone gives maximum response when it is impulsed at rates near to 1000 per second.

(b) It is less difficult for the operator to distinguish between wireless telegraph signals and the interfering discharges of atmospheric electricity.

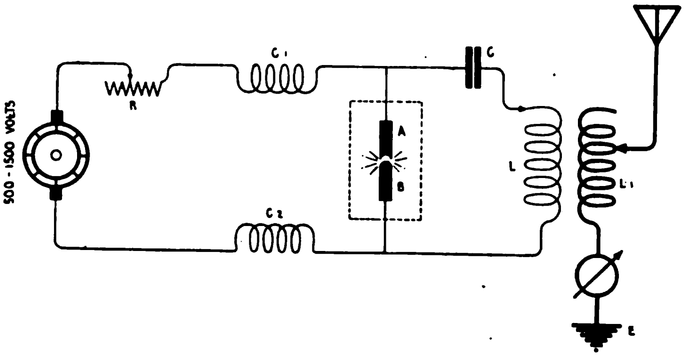

Figure 183

OBJECT OF THE DIAGRAM

To show the fundamental circuits of the Poulsen arc generator.

PRINCIPLE

Because of the "falling characteristic" of the D.C. arc, in other words, its instability, an inductance-capacity circuit may be shunted across the arc for the production of continuous oscillations.

DESCRIPTION OF THE DRAWING

The arc gap is represented by the **copper** and **carbon electrodes** A and B. The gap is energized by the D.C. generator at voltages from 500 to 1500 volts. R is a ballast or **regulating resistance.** C-1 and C-2 are **iron-core choke coils** to prevent the radio frequency currents flowing in the circuit L, C, AB, from discharging back into the generator. C is the **condenser** and L the **primary inductance** of the oscillation transformer. L-1 is the **secondary inductance** connected in series with the antenna as usual.

OPERATION

The functioning of the arc generator for the production of continuous oscillations can be explained in the following way, but it must be understood that the mode of operation under some adjustments are very complex and require classification, in other words the arc is capable of **generating several types of oscillations,** certain of which are desirable and others distinctly undesirable.

It is to be understood that the **gaseous section** of the arc **does not possess constant resistance,** and it, therefore, does not obey Ohm's law, that is:

> **(a) If the potential difference across the arc is high, its resistance is large and the flow of current is relatively small.**
>
> **(b) If the potential difference across the arc is low, its resistance is low and accordingly the flow of current is relatively large.**

In the region of current flow corresponding to the conditions in (b) the arc is unstable and unless a balancing resistance be inserted in the supply leads from the D.C. generator, the arc will become a short circuit.

It is clear from (a) **that a small increase in potential difference across the arc results in a small decrease in the arc current.** Since this phenomenon is the reverse to that encountered in ordinary circuits whose resistance is constant, the arc is often spoken of as a **negative resistance.**

In the case of the Poulsen arc generator, the operation of the closed circuit in practice is assumed to be as follows, but it should be added that it is doubtful whether this sequence of events remains strictly constant throughout an operating period.

(1) Assuming the arc to be in operation and the condenser connected in shunt: The condenser accumulates a charge, thereby robbing the arc of some of its current.

(2) The decrease of current through the arc in accordance with (a) above corresponds to increased potential difference across the arc.

(3) The condenser therefore continues the charge until the arc voltage becomes stationary.

(4) The condenser then discharges through the arc, increasing the arc current.

(5) In accordance with (b) above, the arc voltage therefore decreases and it thereby assists the discharge of the condenser.

(6) The discharge current from the condenser through the circuit L, C, AB, operates, as in any oscillation circuit, to recharge the condenser in the opposite way.

(7) When the condenser now discharges, its current flows against the current of the arc, and if the condenser current is equal to the arc current the arc goes out.

(8) The condenser cannot therefore complete its discharge, but the supply current is now diverted from the arc and hence it acts to oppose the residual charge in the condenser reducing it to zero.

(9) The supply current then acts to recharge the condenser in the way mentioned at the beginning, that is, it charges the condenser to the voltage necessary to re-ignite the arc discharge, whereupon the cycle of operations is repeated.

(10) The frequency of the resulting oscillations will only approximate that to be expected from the values of L and C. This is due to the fact that the time between the reduction of the arc current to zero and the commencement of the next discharge depends upon the rapidity with which the supply current can recharge the condenser. The arc is therefore apt to oscillate at a fundamental and several harmonic frequencies.

SPECIAL REMARKS

(1) As mentioned previously, several types of oscillations may be generated by the arc system. It is usual to classify them as types I, II, III. Type I represents the case where the **oscillation current is always less than the arc current;** type II, where the **condenser current is the same as the arc current;** type III, where the **condenser current is greater than the arc current.**

Type I oscillations are generally of little importance as the efficiency of conversion is low. Type II oscillations are assumed to be those encountered in the practical operation of the Poulsen arc. The resulting oscillating current is partly a sine wave alternating current and partly a D.C. current. Type III oscillations (due to the lag in the cooling of the arc gap) causes an actual reversal of current across the arc, and the condenser is therefore not recharged by the supply dynamo until the oscillating current has gone through a few swings; in other words, in a circuit where type III oscillations exist, there results groups of damped oscillations much similar to those obtained in spark radio telegraphy.

(2) It is found that the best results are obtained when the **direct current voltage is from 500 to 1500 volts** and the **positive arc electrode is rapidly cooled.** Water is generally circulated through the positive electrode, which is hollow and of copper. The rapid cooling of the arc assists in producing energetic oscillations because it allows the arc to die out rapidly and shortens the time of the condenser charging period.

(3) Increased efficiency is secured, that is, more energetic oscillations are obtained by surrounding the arc with **hydrogen gas.** The gas assists in cooling the ionized vapor between the arc electrodes. **Illuminating gas, alcohol, ether** or **steam** can be used in place of hydrogen.

(4) The oscillations are made still more vigorous by the application of a **magnetic field at right-angles to the arc.** The action of this field is to **deflect the arc to one side,** thereby **increasing its length and consequently the potential difference.** The magnetic field also assists in **blowing out** the conducting ions formed in the gas, thereby increasing the potential difference between the electrodes. This has the effect of giving the condenser an increased charge.

(5) Satisfactory operation is secured only by establishing the correct relation between the **strength of the magnetic field,** the **arc current** and the **length of the arc.** These adjustments are obtained by experiment.

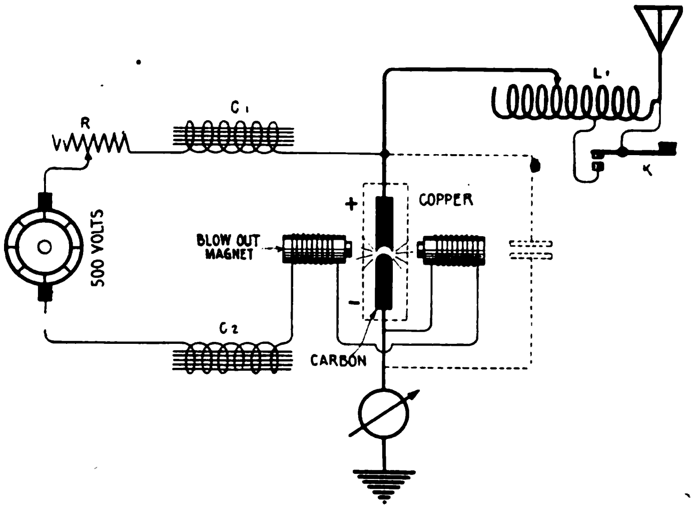

Figure 184

OBJECT OF THE DIAGRAM

To show the fundamental circuits of a modern arc transmitter.

DESCRIPTION OF THE DRAWING

A 500 cycle D.C. dynamo supplies current to an arc gap consisting of a **positive electrode of copper** and a **negative electrode of carbon** enclosed in a **containing vessel** to which is supplied **hydrogen** or **illuminating gas.** In series with the supply mains are placed **powerful electromagnets** which are mounted at right-angles to the arc gap. The supply mains also include the **iron coke choke coils** C-1 and C-2, and a **ballast resistance** R, which prevents the arc from effecting a short circuit. The coils C-1 and C-2 help to maintain the supply current at a constant E.M.F. (there is some argument on this point, for it is believed that these coils act in some circuits to cause a potential difference across the condenser that greatly exceeds the voltage of the supply generator).

The important feature of figure 184 is that the arc gap is connected directly in series with the aerial circuit.

The length of the radiated wave is varied by the aerial inductance L-1.

Signaling is accomplished by means of the key K, which shunts a portion of the aerial tuning inductance; thus when the key is up the antenna radiates a short wave, and when the key is down it radiates a longer wave. If the receiver is tuned to the wave length emitted when the key is down, the signals that are radiated when the key is up will not be received; in other words, signaling is effected by changing the wave length of the radiated wave.

The function of the condenser (in dotted lines) shunted around the arc is to act as a bypass for the radio frequency currents of the aerial circuit, thereby avoiding the necessity of passing the entire antenna current through the arc.

SPECIAL REMARKS

(1) It is through the features shown in figure 184 that the arc transmitter has been brought to the degree of perfection required for commercial application.

These features are:

(a) Placing the arc in an atmosphere of hydrogen.

(b) Using a carbon electrode for the negative side and a water cooled copper electrode for the positive side.

(c) The employment of a transverse magnetic field.

(d) Slowly rotating the carbon electrode by a small motor (not shown in the drawing).

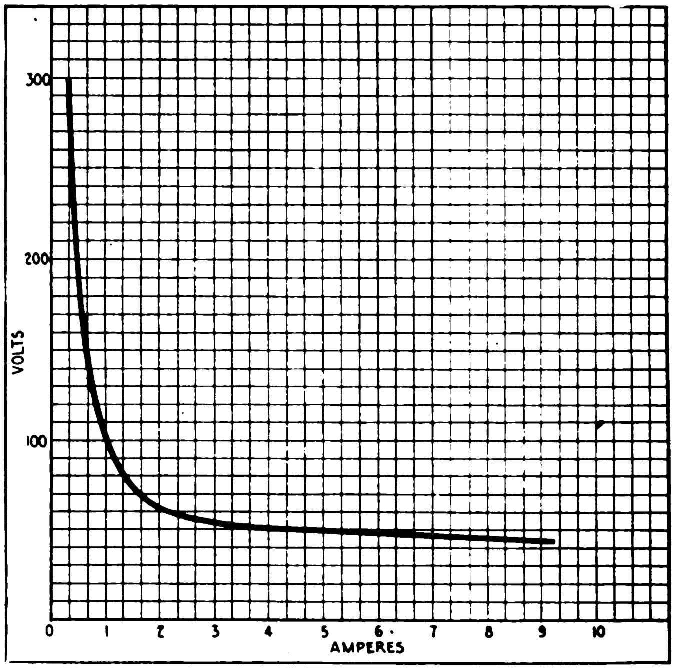

Figure 185—Showing the so-called static characteristic of the arc, that is, the relation between potential difference and arc current when D.C. current is applied to the arc gap. The important point to be observed is that large arc currents correspond to a small potential difference whereas small currents correspond to a high potential difference. This phenomenon is accounted for by the fact that if an increase of arc current is produced by increasing the E.M.F. from the source of supply, greater heat is produced at the negative electrode and therefore greater ionization. The increased number of electrons thus made available for conduction, results in increased conductivity or lower resistance. The supply E.M.F. is therefore enabled to cause an increased flow of current which continues and the voltage required to maintain the arc decreases towards a definite minimum.

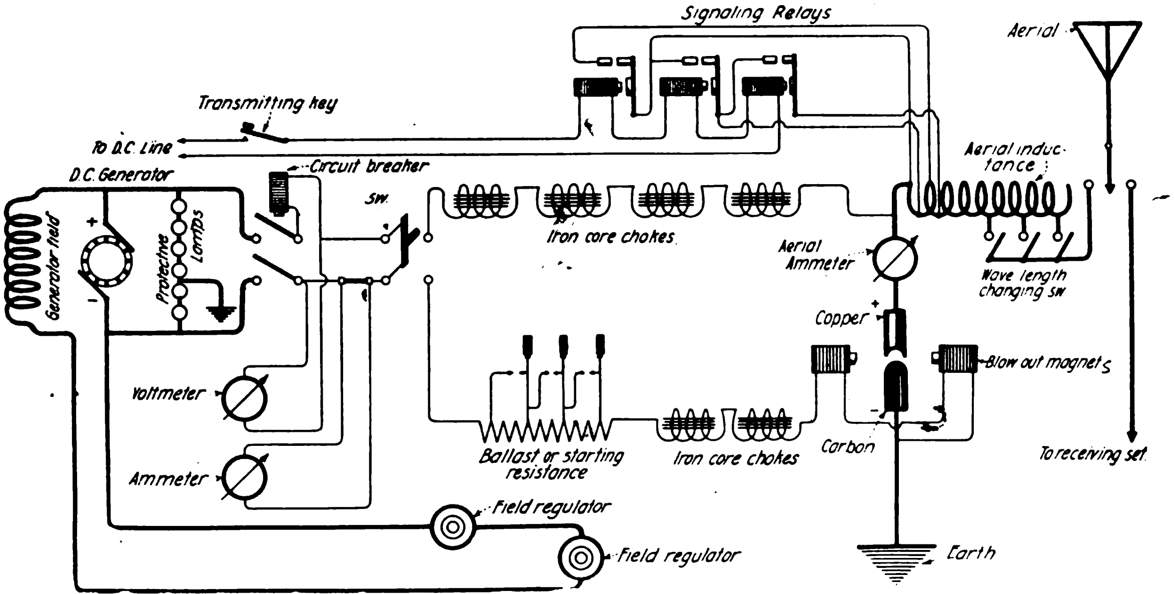

Figure 186—Complete circuits of a modern arc transmitter of the Poulsen type from the D.C. generator to the aerial. D.C. current at 500 to 1500 volts is fed to the arc gap by a generator with variable field resistance. The starting resistances permit regulation of the arc current for maximum efficiency and prevent short circuit of the generator during the preliminary adjustments. The iron core choke coils serve to protect the generator from the radio frequency current flowing in the antenna circuit. Protective lamps are connected across the generator and earthed as shown, four lamps in series on the positive side and two lamps in series on the negative side. Powerful blow out magnets are placed at right-angles to the arc gap. The arc discharge takes place in an atmosphere of hydrogen or illuminating gas. The wave length of the transmitter is varied by cutting in and out turns at the aerial tuning inductance. Maximum aerial current is observed by the aerial ammeter. Signaling is effected by magnetic relay keys which short circuit a portion of the aerial tuning inductance thereby changing the length of the radiated wave.

Signal Officers' Training Course*

A Wartime Instruction Series for Citizen Soldiers Preparing for U.S. Army Service

By Major J. Andrew White

Chief Signal Officer, American Guard

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Eighteenth Article—Coast Defense Information in War

IN general it appears evident that the service of security and information in coast defense, as in the field, implies, first, the collection of military information or intelligence; second, its transmission; and, third, its correlation and use. In regard to the first of these elements it may be said that the **collection of information** is primarily the duty of the coast patrol, but in war becomes the duty of the mobile army, the fixed defenses, and of every man of the government service, both civil and military, and, indeed, of all people of the country. But although important information may thus come from many sources and, no matter what the source, should be transmitted to proper authority, yet incidental information, like incidental soldiering, is merely auxiliary to the organized service of information. The continued value of this service depends upon a properly organized corps of men who will transmit the reports of trained observers from the aircraft, signal, and observation stations, from lighthouses and other government establishments, from the floating auxiliaries and ships as well as from chance sources of information, and from the thousand watchers of the coast, upon all of whom reliance must be placed in war to collect that information upon which will depend the attitude of the defense.

But both judgment and experience in regard to the weight to be given this information will be needed by officers and men in charge of this service, and of its transmission, if a constant condition of unrest and excitement is to be avoided at inshore terminals. Who can doubt, for example, that information received at the centers of control will determine the attitude of the army of the defense in threatened areas, and perhaps its ability to prevent surprise or repel attack; that the news or no news, often equally important, from the coast will govern the preparedness and vigilance of the mobile troops and supports and keep the artillerymen at the guns or give them release; that, in short, a well-organized service provided with trained men skilled in the use and maintenance of lines of information will relieve the defense of the greater part of its strain in the absence of the enemy, multiply many times its efficiency in his presence, and permit the smaller force to do the work of the larger. While, on the other hand, an insufficient service of information, handicapped by slow, inaccurate, or faulty transmission, will plague and worry the defense with useless anxieties and alarms, if it does not even lead on to disaster.

British Off. Photo

Coast artillery fire control utilizes the searchlight for code flashing

The **transmission of information,** which is the second element of the service of security, is a duty of vital importance, which should be intrusted only to trained men under military control, supplied with the best known appliances for this service, and should never be left to the chance efforts of any irresponsible person who can use a telegraph key or a radio instrument. In other words, that the section of the coast guard to which **the duty of transmission of information is intrusted should be composed of men trained in naval and military signaling and familiar with the methods of the Signal Corps of the army.**

With the use that will be made of the information when received, which is the third element of the service of security, the patrol has no concern, since this will depend upon commanding generals, and the reception and correlation of reports upon staff officers at headquarters, presumably signal officers, whose duty it should be to formulate and weigh the information transmitted.

It appears that the coast patrol will become in the future one of the strongest arms of that service of security and information upon which so much dependence is necessarily placed in modern war. It follows, and it cannot be doubted, that this patrol or guard when organized should be thoroughly efficient in numbers, personnel, organization, and equipment, and that its men, who are frequently placed at lonely stations and required to act upon their own initiative, should be not only steady, well-disciplined soldiers, but in addition must be carefully selected, intelligent, and keen men, skilled as observers and trained in the use of the telegraph and of mechanical appliances. Besides all this they should possess that judgment which seldom blunders in its work. Fortunately for the country, men of this character are many in civil life and will be found in abundance when called, but these men must be trained as soldiers.

The work of installing the fire control was formerly performed by the Signal Corps of the army, and many of the types of instruments used have been designed or adapted by the corps. But in addition to the fire-control systems there must exist both within and without artillery districts the fifth factor of the coast defense, that is lines of information, whether electrical or visual, by means of which artillery headquarters are kept in touch with the interior of the country and with centers of control; the factors and elements of the defense are brought into co-ordination; fixed positions connected; and the district bound into a whole under control of its commander, as an army in the field is linked together and maneuvered by its general.

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*This article is abstracted from General Scriven's tactical observations, contained in the complete volume, "Military Signal Corps Manual," by Major White.

These units are, as a rule, separated from each other by considerable distances. Each headquarters, however, is kept in touch with the others electrically, mainly through the commercial systems of the country; but the commercial systems are, of necessity, frequently supplemented by military lines, which extend them to artillery headquarters.

Press Illus. Svce.

For coast defense, means must be at hand for providing temporary lines of communication

In general, artillery lines of fire control and of information (except the field lines necessary in maneuvers) are, in peace, permanent in type; but in war to permanent lines are added a network of temporary systems as flexible and extensive as need be, and in character resembling those of an army in campaign. These may be more limited in extent, perhaps, but based on more stable conditions they are consequently easier to install and maintain against interruption by an enemy, except in the case of the radio. If interrupted, repairs are easier made, since the material should always be at hand at the fixed positions. But as with lines of information in the field, those of the coast defense, both permanent and temporary, must be certain and speedy. They will be more complicated and varied than is possible with the former, since they imply, in addition to land lines, systems of information extending both under and over the sea, and include in their scope every known method of transmitting intelligence from the wink of the ardois, the flash of the searchlight, the tick of the telegraph key, or call of the buzzer to the message of the long-distance radio and of the airplane or dirigible.

With the permanently laid lines of the coast defense transmission should, of course, be as efficient and satisfactory as in civil life if the systems are properly installed and skillfully operated in practice; but in order to secure these results it is evident that the ponderous permanent systems of the fixed defenses, both fire control and information, cannot be thrown out in an hour like the wires of a marching army, but must be carefully planned and constructed in advance as the defenses themselves are planned, must progress to completion with them, and when in place must be proof against reasonable probability of interruption.

Temporary lines will, of course, be installed only when demanded by the exercises and maneuvers or by the exigencies of war. Nevertheless, the means of providing them should be at hand within each artillery district, so that when needed field telegraph and buzzer lines may be laid easily, quickly, and without confusion from district headquarters to the supports, mobile troops, to headquarters and observation stations of the coast patrol. The telegraph and telephone, radio sets and visual appliances should be in readiness for use in the exchange of signals between the fixed positions and coast-defense ships, patrols, picket boats, and scout ships, as well as torpedo planters and the cable ship when necessary, and with the navy. The field telephone should be ready to tell its story from observation stations and the airplane and dirigible should be at hand to send by radio or visual signals their messages from land or sea. Thus the temporary lines of artillery districts will include many aerial systems, and even the permanent communications will not be electrical alone. Both will depend largely upon the auxiliary, but still very important, class of visual and oral signals, which before the introduction of the radio telegraph were the only means known of exchanging ideas without material connection. Visual signaling is probably more important in coast defense than with the army in the field and is vital when communication is needed between ships and shore and the radio is silent. Whether all the signal apparatus outlined will be used by the defense is another matter; still the possibility exists, and the fact remains that opportunity should be given those who have control to employ every method of transmitting information that may prove reasonably valuable. To do this it is necessary that signal appliances of all useful kinds be stored in depots within artillery areas, in addition to the material required for the emergency repair of permanent systems.

Com. Pub. Inf.

A duplex set for long distance communication such as is required in war to supplement existing commercial systems

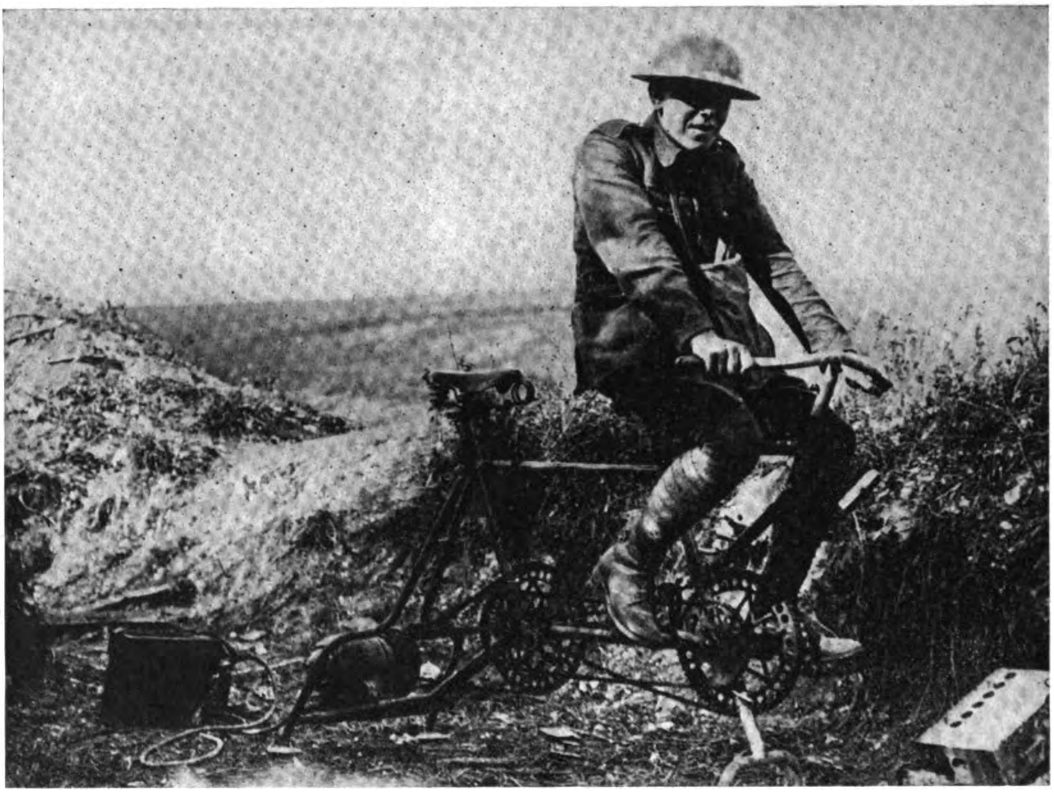
In war the headquarters of each artillery position, even more than coast patrol stations, becomes a nucleus of intelligence regarding events at sea, and therefore the service of information in and from these districts should be as perfect as it can be made.

Signal Corps News

Officers' Training Centralized at Yale

Men seeking commissions in the Signal Corps of the army will receive their training at Yale University, it is announced. This centralizes training in this branch and makes possible full use of the university's faculty, which will be further augmented. The instruction personnel will be civilian and not military, although students enrolled will be in uniform, and officers, some of them coming from the front, will keep in close touch with the university.

Men detailed from the Government Radio School for Signal Corps officers are already arriving at Yale. About 100 have been transferred from College Park, Md., and others are coming from all parts of the country. These men are graduates of electrical engineering courses or are especially qualified for the work. Eventually there will be 300 men under training in this course, which will cover three months.



British Off. Photo

Apparatus captured by the British from the Hun who used it to generate electricity for their wireless stations

* * *

Rank of Ensign in Army Urged

According to the American Army Gazette, a bill is being prepared to recreate the rank of ensign in the army for men who will be non-commissioned officers appointed by the Secretary of War and will rank below a second lieutenant, but above a first sergeant and a sergeant-major.

The need for a rank of this kind cannot be gainsaid. The pay of the non-commissioned officers of the army at the present time, while commensurate perhaps in some cases with their duties, does not begin to compare with the pay of the petty officers of the navy who are doing practically the same character of work. At the present time, outside of master engineer, master signal electrician and master electrician, there is no rank in the army corresponding to the ranks of boatswain, carpenter and gunner in the navy.

The proposed bill will allow the Secretary of War, upon recommendation of commanding officers, to issue warrants conferring the rank of ensign upon sergeants and corporals who have had more than six months' service, who will receive pay at the rate of $110 a month; not only in the line, but in specialized branches of the service, such as the signal, electrical, engineer, artillery and coast artillery corps.

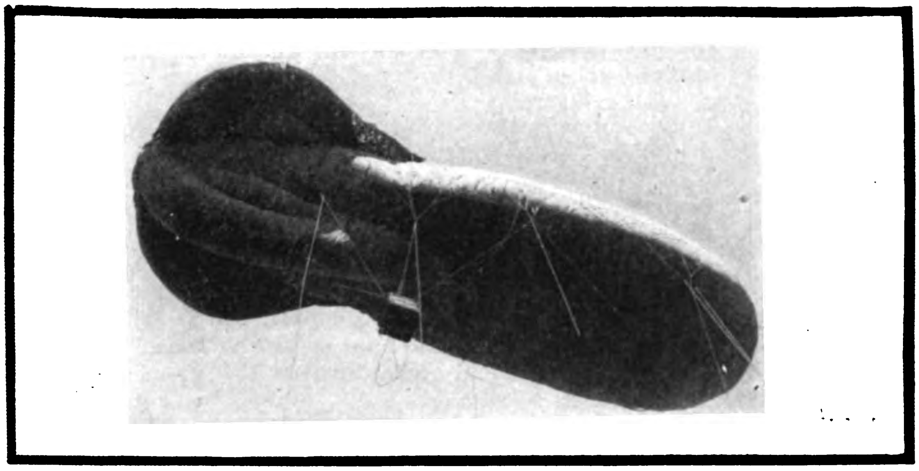
The details of the proposed act will closely follow the lines of the law for warrant officers in the navy.

The fact that at present men of highly specialized ability are daily being inducted into the army and immediately given duty for which in civilian life they received hundreds of dollars a month, and for which in the army they receive but $30 a month, does not make for a high morale in the enlisted personnel.

Instances without number might be cited of men in the army who are to-day working side by side with civilians doing the same character of work, and for which they are receiving one-fifth to one-tenth as much pay, because the civilian is perhaps incapacitated for service either by physical disability or by age limit.

The principal reason, however, for the need of a measure such as is proposed is to take care of the line soldier. Many men in the army who have risen step by step to the grades of corporal and sergeant, and have shown their peculiar adaptability for army life, are still hardly qualified for a commission. It is ridiculous to pay some of these men the paltry sum of from $44 to $60 a month in these days of high wages.

Scenes at the Army Balloon School

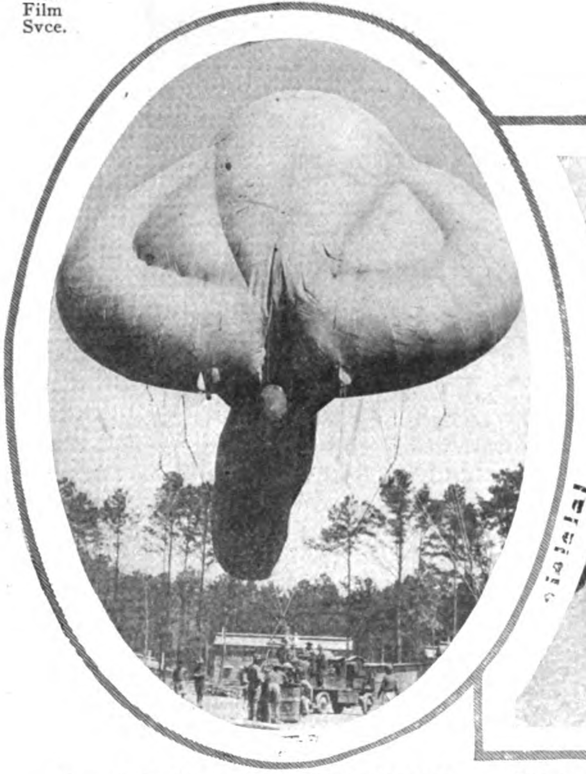


From observation balloons like the one illustrated above the skilled army observers spot the hits of artillery shells and make general tactical reconnaissance notes for the commanding general. These captive craft are ordinarily placed several miles back of the scene of combat and are protected by a patrol of combat airplanes. Reports are made by wire telegraph and telephone and by radio

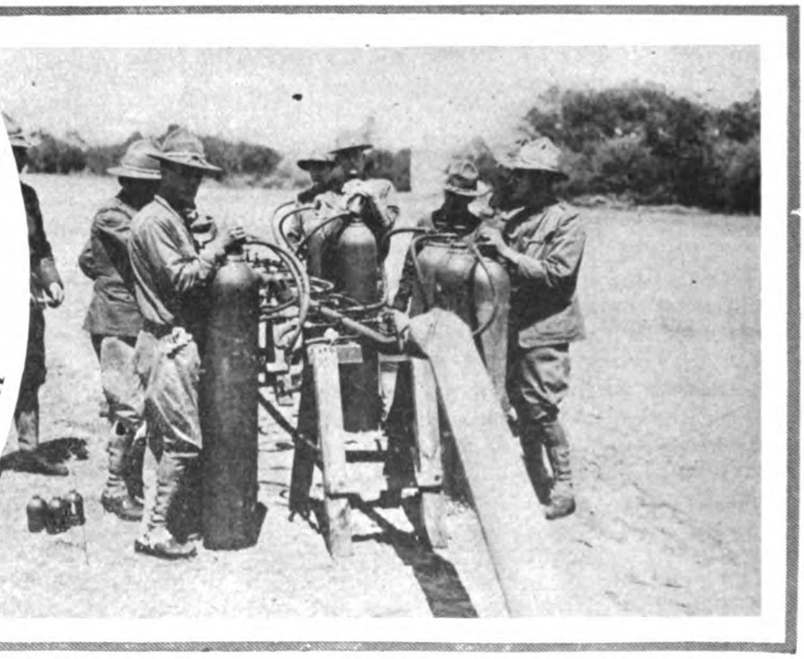
To the left, Major General W. L. Kenly, Chief of the Bureau of Military Aeronautics in conference with Major Burwell

Photos Int. Film Svce.

When the observation balloon is to be lowered the engine installed on the bed of this truck operates a winch around which the steel anchor cable is wound



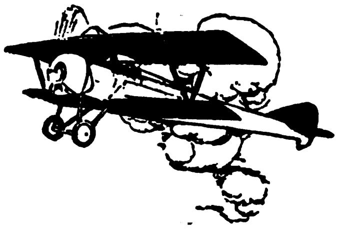
One of the big gas bags in mid-air; rear view, showing the ballonet and rudder inflated



The ground crew with the steel bottles which fill the balloons with gas. This gas is hydrogen, supplied by electrolytic generators, or made from ferro silicon and caustic soda

How To Become An Aviator

The Sixteenth Article of a Series for Wireless Men in the Service of the United States Government Giving the Elements of Airplane Design, Power, Equipment and Military Tactics



By J. Andrew White
and Henry Woodhouse

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Preparations for Cross-Country Flight

QUALIFYING tests for Junior Military Aviator prescribe two cross-country flights, one of approximately 60 miles and the other 90 miles. When these flights are undertaken the student aviator is expected to know all the fundamental technique of flying, turning and landing, and have reached the stage where the operation of controls is no longer a task but a matter of instruction routine, so to speak; in flying cross-country, therefore, he is enabled to give a large share of attention to following the course and selecting proper places should an emergency landing be required. Prior to the flight a few matters of importance require attention:

EQUIPMENT

The usual flying clothing is worn, the only caution being to provide for sufficient warmth. Leather suit and helmet are worn, supplemented in winter by sweaters and mufflers. Hands and feet are most sensitive to cold and should be well protected; provision of large boots with woolen socks or stockings will repay the aviator in comfort. On a long flight it is well to take two pair of goggles, in case one pair should be lost or broken, and a handkerchief to clean them is necessary. An identification card and money should be carried for emergencies; the telephone number of the airdrome should also be noted and a complete set of tools and covers for propeller and cockpit should be carried.

STANDARD EQUIPMENT—AIRPLANE TOOL CHEST

(Cover.)

1 Saw, hand, 26″.
1 Hammer, riveting, 8 oz.
1 Combination square, bevel and level, 12″.
1 Rule, folding.
1 Hacksaw, frame.
1 Dividers, pair, 6″.

(Top.)

1 Wrench, Stillson, 14″.
1 Screwdriver, 8″.
1 Screwdriver, 7″.
1 Screwdriver, 5″.
1 Nailpuller.
1 Knife, draw 8″.
1 Hammer, tinsmith's, 1 pound.
1 Hammer, claw.
1 Tape, steel, 100 feet.
1 Brace, 10″.
1 Iron, soldering, 1½ lbs., 1 iron, soldering, jeweler's.
2 Center punches.
24 Blades, Hacksaw, coarse; 12 blades, Hacksaw, fine; 1 Chisel, cold, ¼″; 1 Chisel, cold, ½″.
1 Calipers, 6″.
1 Wrench, monkey, 6″.

(Upper Drawer.)

1 Bit, expansive, ⅞ to 3″.
1 Pliers, round nose, 6″.
1 Pliers, snipe nose, 4″.
1 Pliers, adjustable, 8″.
1 Pliers, side-cutting, 8″.
1 Pliers, adjustable, 6″.
2 Pliers, auto, combination cutting, 6 and 8″.
1 Nipper-cut, 7″.
2 Pliers, diagonal, 6″.
1 Pliers, compound, side-cutting, 8″.
1 File holder.
1 Spoke shave, 3″.
1 File cleaner.
10 Files, assorted, with canvas roll.
1 Screwdriver, 4″.
1 Palm, sewing; 8 needles, assorted; 1 ball flax and 1 ball wax.

(Lower Drawer.)

1 Stone, carborundum, 5″.
1 Torch, gasoline, flat.
1 Set thin open-end wrenches with canvas roll.
1 Set drills, Morse, straight shank, with canvas roll.
1 Plane, block, 1⅝″.
1 Drill, hand.
1 Wrench, 7″.
3 Reamers, taper, bit stock, 1¼, 1 5-16, and 1 ⅛″.
1 Hatchet, half (small).
1 Snips, tinners.

The machine should be carefully inspected, from tires to instrument board, before the start. Wires, controls, engine and gasoline and oil reservoirs are matters to be looked into by the aviator, who must not accept the word of mechanicians that everything is ready. The instruments required are a compass, wrist watch, altimeter, tachometer, inclinometer and a map board or case. The map case is highly preferable as maps pinned to a board often blow off or are torn in long fast flights.

The map is a most important part of the aviator's equipment for a cross-country flight. It should be placed in a position of easy visibility, such as on the instrument board, or, in any event, as nearly as practicable straight ahead in the line of vision. The course should be carefully mapped out and notations made, as discussed in succeeding pages. On a long journey a weather report obtained by telephone from the point of destination may save trouble should fogs or storms be prevalent there.

PHYSICAL FITNESS

The aviator should have no hesitation in informing his instructor or flight commander of any indisposition; if he does not feel well a cross country flight should not be attempted, as the correct functioning of all his faculties will be required. A long flight on an empty stomach is bad, as dizziness often results. At least a hot drink should be secured, and a good meal if possible. Food in tablet form, chocolate or biscuits may be taken along, but should be placed in a position of easy access.

MAP READING

The aviator must know how to read a map before cross-country flights can be made. An understanding of the meaning of conventional symbols and application of the scale are the main essentials, extensive knowledge not being necessary.

A typical military map is shown in Figure 100.

DEFINITIONS OF TERMS

In mapping, many terms are used, a number of which such as basin, crest, gorge, knoll, plateau, and watershed are universally familiar. A few special terms are defined here, however, for the simplification of the subject.

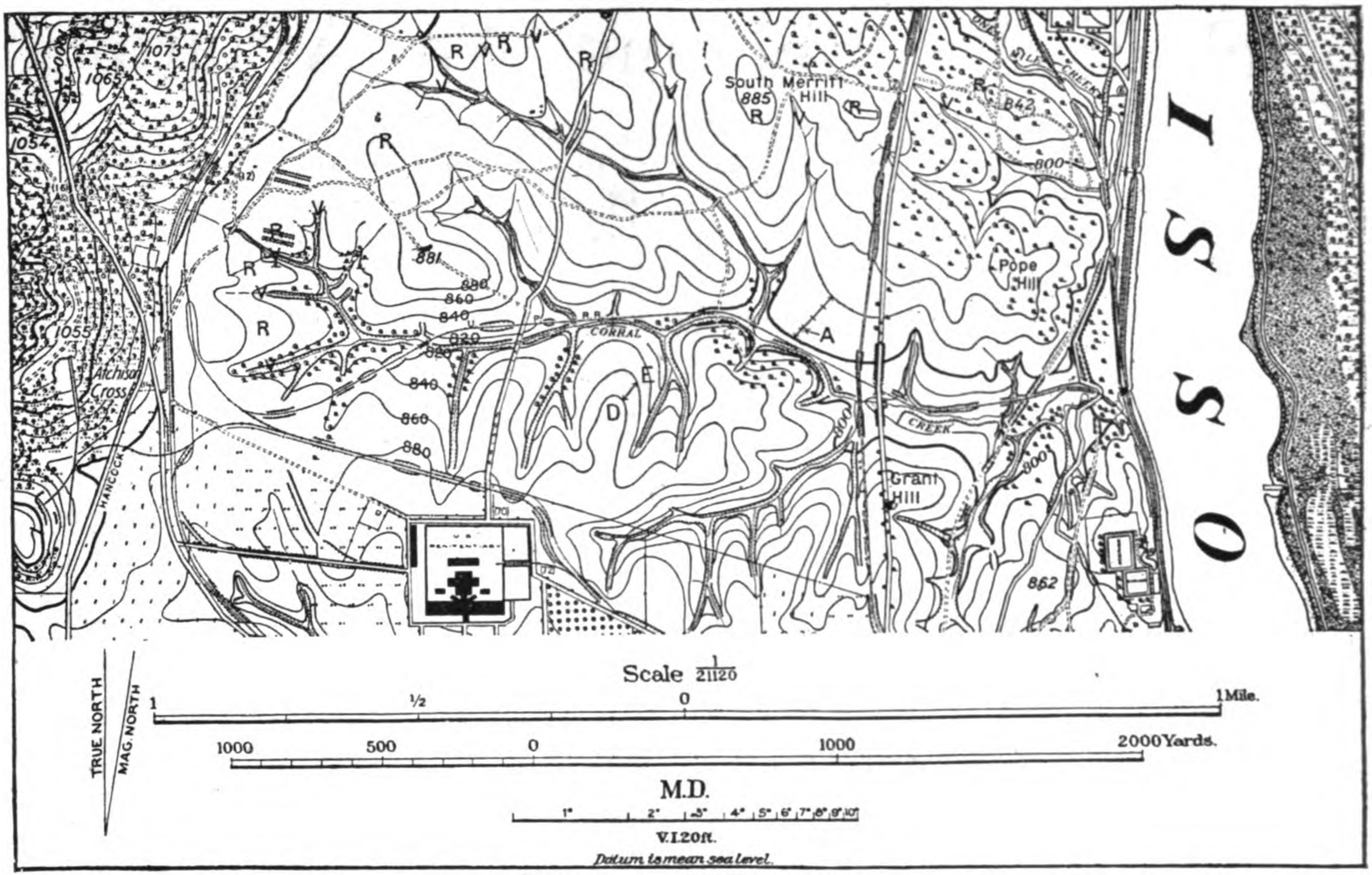

Figure 100—A typical military map

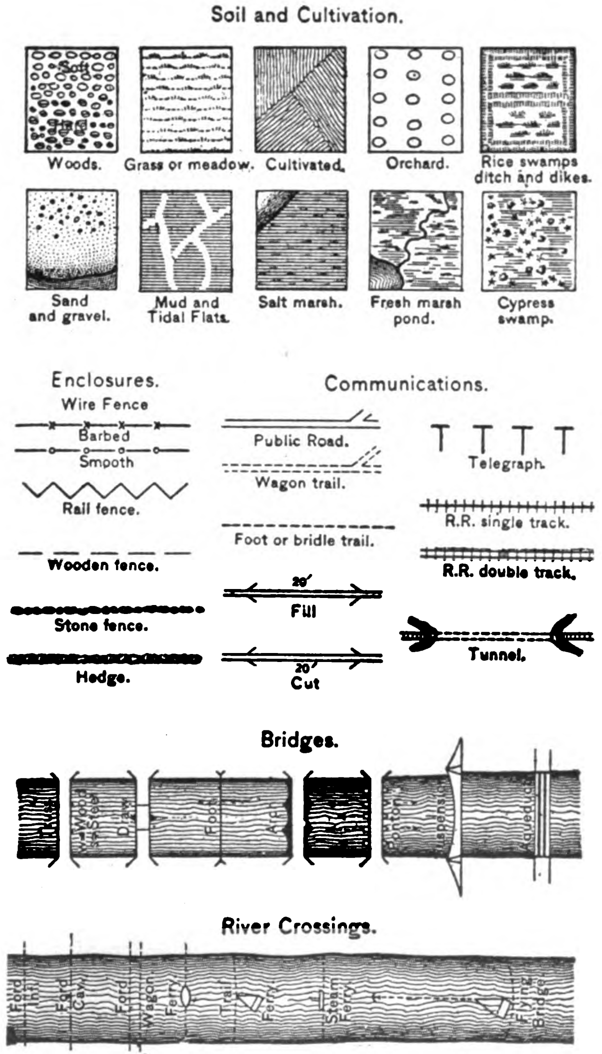

Figure 101—Conventional signs for maps

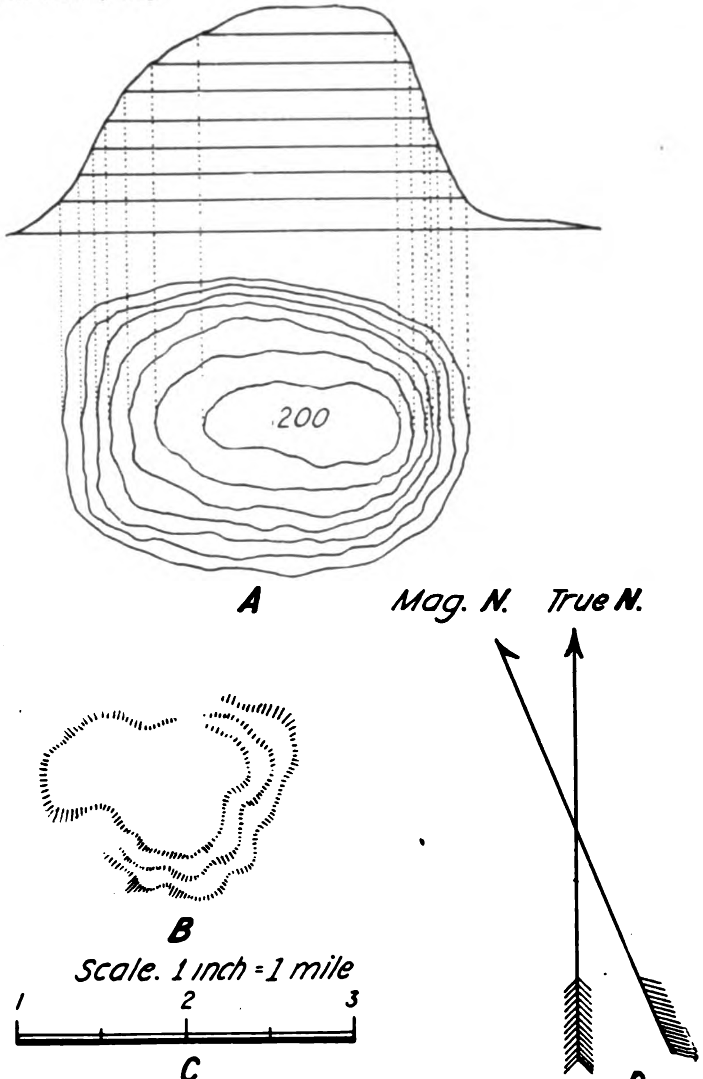

Figure 102—Height, distance and direction symbols

Bearing—The relative position or directions with the north, or true meridian; *magnetic bearing*, the relative position or direction with the magnetic north.

Contour—A line designating the shape, outline or boundary at a fixed height of a section of ground; contours are used to indicate elevations, each contour representing a rise or fall in feet from those surrounding it. Illustrated by *A*, Figure 102.

Gradient—This indicates a slope expressed as a fraction, a gradient of 1-50 designating a rise of 1 foot in 50.

Datum—A fixed level (generally sea level) from which all heights are measured.

Hachures—A shading method of representing hills, short strokes being drawn directly down the slopes. Illustrated by *B*, Figure 102.

Meridian—A true north and South line.

ORIENTING

The first thing to be determined is: Where is the north? On a map this is usually indicated by an arrow placed in one of the corners. Some maps do not have an arrow, in which case it is a generally safe assumption that the top of the map is the north. When two arrows appear, as in *D*, Figure 102, one points the true north, the other the magnetic north. Usually they are so marked, but if not lettered, the incomplete or less elaborate arrow represents the magnetic north. The magnetic north is the north of the compass; its deviation from the true north has already been explained. When the map has been turned to its proper position, i. e., the magnetic north arrow corresponding with the compass, it is said to be oriented. This is the first step tor the aviator about to lay out a cross-country flight.

THE SCALE

Having located his position on the map, the next features for the aviator to study are the distances between points. These are shown by the scale, which appears usually on the lower end of the map; for example, two points are measured by ruler on the map and the distance is 1 inch; the scale reads: 1″=1 mi. (as in Figure 102), then the actual distance between these points over the ground will be found to be 1 mile. Some maps state: (so many) miles to the inch; the measuring procedure is the same, allowance being made for 2 miles to the inch, or whatever the scale states. What is known as a representative fraction is sometimes used. On the map, Figure 100, this appears as $\frac{1}{21120}$. If the R.F. is $\frac{1}{100}$ it means that an inch on the map is equal to 100 inches on the ground; the fractions are usually large, such as $\frac{1}{63,360}$, which would indictate an inch to a mile, since there are 63,360 inches to a mile. On foreign maps $\frac{1}{100,000}$ is a familiar fraction, and may indicate either inches or millimetres; in all forms the principle is the same and the scale is reckoned in the same way, afterwards being calculated in inches by the aviator. Another method of showing the scale is illustrated on the map, Figure 100, where it is only necessary to copy the scale on a strip of paper and apply the slip directly to the map, reading off the distances between any designated points.

CONTOURS

Contours on a map show the elevations, depressions, slope and shape of the ground.

Hachures (see *B*, Figure 102) sometimes used on European maps, show elevations only and are of little value. The method of indicating features by contour lines is clearly shown in the illustration *A*, Figure 102. The irregular, curving lines which appear on the map represent the outlines of the hill at equally spaced vertical intervals. If, for example, by use of a surveying instrument a line of stakes was placed around a hill, each one exactly the same height above sea level, a line drawn on the map through all the stake positions would be a contour. Study of the diagram *A*, Figure 102, will make it clear how the steepness of hillsides is determined from the map, contour lines close together indicating a steep slope, and far apart, a gentler slope.

On some maps contours are numbered in elevation in feet above the datum place, generally sea level. Thus, at a glance, the elevations are clearly determined.

CONVENTIONAL SIGNS

Interpretation of the symbols used on maps means for the aviator a quick reading of the natural and artificial features of the country. The principal conventional signs used by the U. S. Army are given in Figure 101, and should be memorized. Conventional signs are not drawn to scale on maps, but ordinarily indicate only the position of the feature.

MAP PREPARATION

The squadron headquarters prepares route and area maps in advance, so that proper maps are on hand when flight orders are issued. The work is so regulated that blank orders to pilots and observers can immediately be filled in and all papers and instructions made ready in a few minutes. Usually the headquarters personnel marks off the course for the pilot, indicates the 5 or 10 mile intervals and the "legs" of the journey. A margin for entering the various data is always left on one side of the map.

USE OF COMPASS AND ITS ADJUSTMENT

The compass is an instrument for indicating the magnetic north by a magnetized needle on a pivoted card. While cross-country flight is possible with the aid of a map and identifying landmarks, at times when these are obscured the compass is a necessity to the aviator.

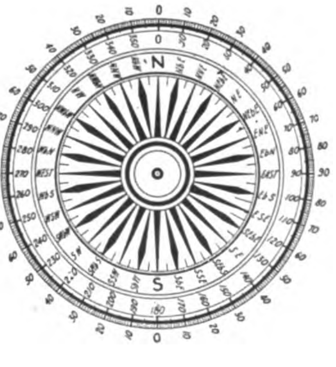

Figure 103—Compass card

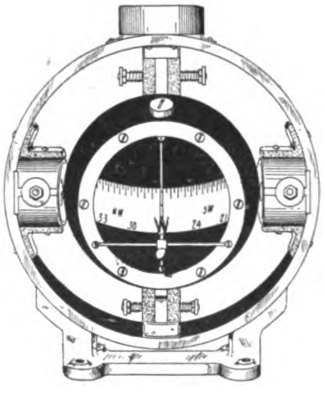

Figure 104—Vertical compass

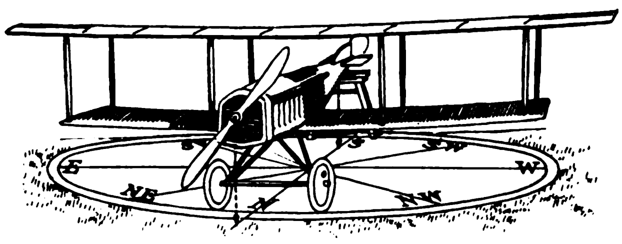

Figure 105—Adjusting the compass

Steering by compass accurately, reference to the map is not required in flight, providing preliminary calculations are accurately made as outlined further on.

THE COMPASS CARD

The card is illustrated in Figure 103. Marking in degrees is clockwise, the circle beginning at N (north) as zero, and comprising 360 degrees. The card is also marked in the old form of the merchant marine; north, east, south and west being represented by 90 degrees, bearings being read, for example, 20° W. of N. An aviation compass of the vertical type is illustrated in Figure 104.

COMPASS ERROR

Variation—The compass indicates the magnetic north from any given place; i. e., the compass magnet points to the north magnetic pole, situated on a northern island of Canada. This is not the "true" north, and it is therefore necessary on maps of the various parts of the earth to make the correction known as variation. This is the angle between the true and magnetic meridian at the point mapped.

Deviation—Since the compass needle is magnetic and the airplane contains much metal of magnetic attraction an error known as deviation is caused which deflects the needle some degrees to the east or west.

Adjusting the Compass—To correct the deviation error is a task seldom assigned to the aviator, but some idea of how it is accomplished will be found of value. (The process which we term adjusting, is known in England as "swinging" the compass.) The airplane is placed with its fore and aft axis exactly north and south, either by aligning it with a tripod "land" compass placed nearby, or by placing the airplane on a cement slab provided for the purpose in many flying fields. The airplane is trued up, in the latter case, by spirit level and plumb line, as illustrated in Figure 105. The compass has what is known as the "lubber's line," which is then fitted to the fore and aft line of the airplane. The compass reading is then taken, and by inserting small field magnets in slots provided for the purpose, the east or west deviation of the needle is corrected until it points north with the cement slab. When the best correction possible has been made a deviation card is generally made out and placed near the compass, for in long flights to a definite objective an error as small as 2 or 3 degrees will throw out the aviator's calculations. A specimen of these cards follows:

For Magnetic Course		*Steer by Compass*	*For Magnetic Course*		*Steer by Compass*
N.	0 degrees	357 degrees	S.	180 degrees	183 degrees
N. E.	45 "	47 "	S. W.	225 "	223 "
E.	90 "	90 "	W.	270 "	270 "
S. E.	135 "	137 "	N. W.	315 "	317 "

PLACING THE COMPASS

The proper location of this instrument is an important matter. It should be placed in clear view and directly in front of the pilot, preferably in the center fore and aft axis of the airplane, as far as possible from moving metal parts such as those of the engine. Metal parts such as control levers and rods, if within 2 feet of the compass, should be non-magnetic, and movable equipment such as machine guns, should be in normal flying position when the compass is adjusted. After any required change in parts is made the compass deviation should be checked and any necessary readjustment made.

A New Protective Condenser

A NOVEL condenser suitable for protection of electrical transmission lines has been designed by E. F. W. Alexanderson of radio frequency alternator fame.

The use of capacity in series with resistance between a transmission line and ground or between the conductors has been proposed for protecting the system from the effect of high frequency disturbances. With such an arrangement the protective path offers a high impedance to current of normal frequency, but a much lower impedance to any high frequency disturbances which may occur in the system. As a result, there will be a flow of high frequency energy through the resistance and a large part of this energy will be dissipated in the resistance. The power factor of a leakage circuit of this kind, however, varies widely with the frequency and with ordinary condensers is normally low. As a means of absorbing high frequency energy such a circuit is most efficient at some particular frequency which depends upon the relation between the capacity and resistance and is less efficient for frequencies higher or lower than this particular frequency.

As indicated in figure 1, Alexanderson's condenser comprises an outer electrode 1 of conductive material and an inner electrode 2 which may also be of any desired conductive material, the space between the two electrodes being filled with an insulating material 3 having a high dielectric hysteresis, such, for example, as asbestos or a compound consisting largely of asbestos. The electrodes are provided with eyes 4 and 5 for convenience in connecting the device to a transmission line. A skirt 6, of porcelain or other suitable insulating material, may be provided to prevent arcing over between the electrodes. A condenser of this type may be connected between a transmission line conductor and ground or between conductors in different phases. If desired, it may be connected between the transmission line and a secondary conductor having a high capacity to ground, so that a breakdown in the protective device will not cause a breakdown in the line insulation. A protective device of this type should be designed with small capacity so that it will have a high impedance for currents of low frequency, but much lower impedance for high frequency currents.

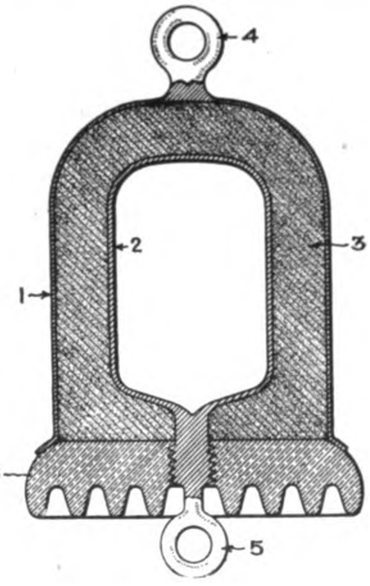

Figure 1—Condenser used to protect electrical transmission lines from the effect of high frequency disturbances

Alexanderson has discovered that the dielectric hysteresis losses of asbestos are much higher than those of materials such as glass, paper and mica, which are ordinarily used for the dielectric medium of condensers, and that these losses increase very rapidly with the frequency.

The power factor of a condenser having asbestos as a dielectric is also much higher than that of ordinary condensers. For example, the power factor of an asbestos condenser at 20,000 cycles was found to be about 38%, while the power factor of similar glass, paper and mica condensers at that frequency was 2% or less. With a frequency of 70,000 cycles, the power factor of the asbestos condenser was over 30%, and that of the paper, glass and mica condensers was about the same as at the lower frequency.

Aviation News

Atlantic Crossed in 24-Hour Flight

Though Navy Department officials said they knew nothing about it, and doubted the story, an article in the United States Naval Institute Proceedings, published in Annapolis, gives details of an alleged twenty-four-hour airplane flight across the Atlantic last July. A somewhat similar story was published in Baltimore in July, but was not credited.

The Annapolis publication says the airplane carried four passengers whose names are temporarily withheld, and that they took a number of photographs showing vessels they passed. The airplane, it says, left the Newfoundland coast at 7.02 A. M. on July 28 and flew continuously, attaining a height of 15,000 feet, for 24 hours and 10 minutes, alighting at Dingle Bay, Ireland, at 7.12 A. M., July 29.

En route the plane encountered an American troop convoy, was duly saluted by whistles and congratulated by a destroyer by wireless.

The actual line of flight was not perfect, as planned, but deviated a number of degrees southward until the destroyer was encountered several hundred miles off Ireland, when a due north course was followed for about fifty-five miles, after which the eastward course was resumed, practically along the originally planned route.

The departure was made under ideal conditions from Harbor Grace, N. F., the course being E. ½ N. true. When 170 nautical miles had been traversed, it was noon and a heavy squall caused the deviation in course.

As night came on, the flyers mounted to higher altitudes, eventually attaining 15,000 feet as a safety measure. It was blind flying at more than 660 nautical miles from land and continued thus throughout the night. The pilots alternated, sleeping and steering, and so did the mechanician and his helper.

At 4 o'clock on Monday morning, July 29, the position was satisfactory and the speed was most gratifying, the engines—12-cylinder affairs—working like a charm. Shortly before 7 o'clock the flyers "shot" the sun and found they were approximately 110 nautical miles from Sybil Head. They easily got their bearings and started on a straight course for Dingle Bay, where they touched the ground at 7.12 A. M.

* * *

Athletic Equipment for Army Aviators

An appeal for athletic equipment, and also musical instruments, for the enlisted men of our aviation forces has been issued by the National Aeronautic Committee, 289 Madison avenue, New York, of which Mrs. Newton D. Baker is honorary chairman, and Mrs. Charles A. Van Rensselaer, chairman. The committee, which is under the direction of the War Department Commission on Training Camp Activities, has received requests from officers in command of army air squadrons going overseas and also from all air training stations in this country, to supply equipment for baseball, football, soccer, basketball, track athletics, volley ball, indoor baseball, medicine balls, punching bags, boxing gloves, etc. Major General Kenly endorses this work, it is stated.

* * *

Lieut. J. A. ("Eddie") Rickenbacker Now an Ace

One of the newest of our American aces fighting with the air forces in France is Lieut. J. A. ("Eddie") Rickenbacker. Many thousands of WIRELESS AGE readers have watched Rickenbacker pilot an automobile to victory in long and hazardous races. It will be recalled that among other trophies, he won the 300-mile speedway record. With such a record behind him it was to be expected that Eddie would give a good account of himself in his new activities.

Rickenbacker enlisted in the air service early in the war and was sent across with as little delay as possible. The same reckless daring which made large crowds all over the country hold their breath when "Eddie" appeared in an automobile has characterized his air fighting. He drives an airplane as he drove an automobile, with consummate skill and an absolute disregard for the hazards involved.

One of the most famous of his encounters occurred on Memorial Day of 1918. Rickenbacker as usual drove his airplane full speed ahead over enemy territory, even when surrounded and outnumbered by enemy fighting craft. He had encountered a German Albatross at an altitude of about 5,000 feet and pursued it fearlessly across the lines. The two had already flown for a distance of three kilometers when the German received reinforcements and two other machines of the same formidable type joined in the battle. The danger of fighting above enemy territory is of course obvious. If the machine from over the line is forced to descend, even if a landing is safely made, the pilot is instantly taken prisoner with his machine.

Rickenbacker was undismayed by the superior forces. His tactics were to keep in the rear of the first enemy airplane and match its evolutions. Although facing three German flyers, Rickenbacker succeeded in outflying and outfighting the fleet arrayed against him. He brought down his man and succeeded in regaining his own lines in safety. Although the battle won the most enthusiastic praise from the French, Rickenbacker insisted that his success was merely good luck.

Int. Film Svce.

With "his hat in the ring" Eddie Rickenbacker, former auto driver and now an "ace" with Pershing's fliers, has just brought down his eighteenth Boche airplane

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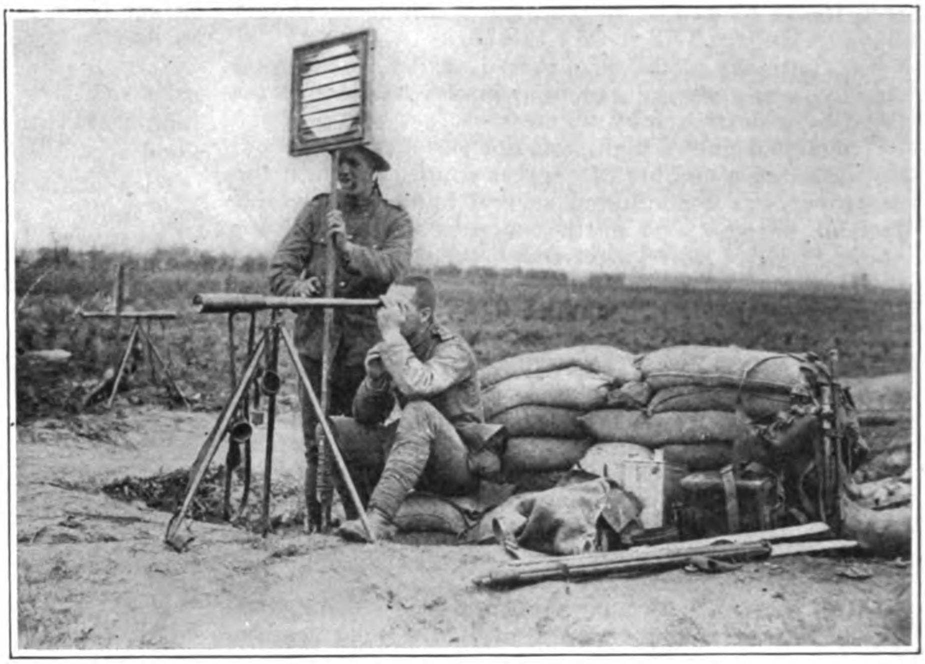
Under Fire With the Signal Corps

(Continued from page 16)

would be impossible. It has recently been rendered possible for the airplane to carry on a radio conversation with the man behind the gun.

It can be seen how great is the advantage which radio communication has over the form of communication which requires the upkeep of wires, since with the radio there are no wires to be shot away, and it requires a direct hit to put the instrument out of action. A new and interesting development is radio telegraphy through the ground instead of through the air. This has been extensively worked out and amplified by the Americans.



Signal Corps men at the battle front communicating by heliograph signals

The third and most extensive network of information is the visual net. The inventive genius of the French has substituted for our wig-wag and semaphore a small searchlight, resembling an automobile headlight, but with a parabolic reflector, which concentrates the rays and enables them to be directed upon one particular spot. This lamp is not only a complete system in itself, but also parallels and duplicates the telephone lines, so that in case they become inoperative they can be replaced by the lamps. It would appear to be no safer to shoot a beam from an automobile headlight into the face of the enemy than it would to get up and wave a flag at him, but the Signal Corps experts seem to have overcome this difficulty, and the way in which it has been done illustrates, we are told, an interesting application of science to the field of signaling.

The visual net makes elaborate use also of the old-fashioned fireworks, which have been in use in armies for years. Almost every infantryman as he goes over the top is equipped with one or more forms of fireworks, whose proper or improper use may mean for him life or death. While fireworks are used principally by the infantry and artillery men, they are trained by soldiers of the Signal Corps and supplied with the right colors and selections. The number of signals which are readily distinguishable from each other under all conditions are limited, and as the enemy is constantly on the alert to pick up their meaning and duplicate them with signals of his own to confuse and mislead his opponent, it becomes necessary to change the entire fireworks code throughout the entire area. It is up to the Signal Corps to develop the code and to transmit the order to change.

The airplanes following the infantry in an advance depend upon fireworks for their communication with the various units whose progress they are watching, and it is only when the front line troops light flares, which they place upon the ground, that the airplane at night is able to determine how far they have advanced and notify their own artillery in case it might be firing on them.

The messenger net, which is a modern adaptation of the runners and mounted messengers, is the fourth means of conveying information. This net serves primarily to transmit long orders and reports, but it is so extensively developed that it may be relied upon in an emergency also to provide complete communication throughout the area. The runners operate as of old, but instead of working on the ground they are winding their way through trenches and into dugouts. A little further back mounted messengers are still employed, but they have almost wholly given way to motor cycle riders.

The feats of the American motor cycle men in France are a mystery to the French. While the French possess motor cycles, they have never made the extensive use of them which the Americans have, and consider them more of a toy than an instrument of warfare. Where the French rely upon the mail for the transmission of orders between various larger headquarters the Americans have established a motor cycle dispatch service with hours of departure and arrival as regular as train schedule in our own country. When the mail is of sufficient bulk it is carried in a side car.

Among the most trustworthy of the messengers must not be forgotten pigeons, which when released from their baskets at the front fly back to their lofts where the messages taken from the little carriers attached to their legs are transmitted to the proper destination. Dogs are frequently used in transmitting intelligence and orders in the present war. The Germans so far have been able to get better results from the use of dogs as information bearers than we have. The airplane also serves as a message carrier. It was probably due to its contemplated use in this manner that the airplane service was originally assigned to the Signal Corps.

These four nets may be developed or extended indefinitely in the future, but it is hard to see how any method of communication can be evolved that will not fit one of them. When we consider the care and patience with which these nets are installed and the amount of time required in their upkeep even in a quiet sector, the difficulties which are encountered in a large advance such as the Americans have just made can better be realized. All the nets in operation are heavily overloaded as the messages fly back and forth by the thousands. As the infantrymen go over the top, the signallers can be seen following behind them, some with fireworks, some with lamps, and some with little breast reels of wire which they lay over the ground, followed by other linemen to attach telephones wherever needed.

When the advance stops, from this flimsy skeleton the new system is built up, and finally again becomes the perfected network. But, as soon as the signaler gets his system once more in a state of perfection he moves again, and it all has to be done over.

The other activities of the Signal Corps offer opportunities for men interested in various branches of science. The meteorological department studies the atmosphere and compiles reports for commanders. These reports include information that affects the care of the troops and the maintenance of supplies, and predictions as to whether the ground will be favorable for troop movement or whether the wind will be right for a gas attack.

The listening-in service is not the least interesting activity of the Signal Corps. There is always a readiness to pick up any information of the enemy that might be of use to us. Accordingly, the Signal Corps has numerous listening-in stations which by means of devices recently perfected not only intercept any enemy radio message, but determine accurately the location of the radio instrument which transmits it. This information is, of course, at once furnished to the artillery, which proceeds to put that station out of business. Even German telephone wires have been made to divulge their secrets, though well within German territory, where it is impossible to tap their lines.

All this is accomplished by one of the most ingenious instruments which has yet been produced. By means of it our Signal Corps man can sit in his dugout on the front line with a receiver to his ear and hear any telephone message within the enemy's territory even though several thousand Huns all jabbering their lingo may intervene between him and the nearest point to the wires.

Some December Articles

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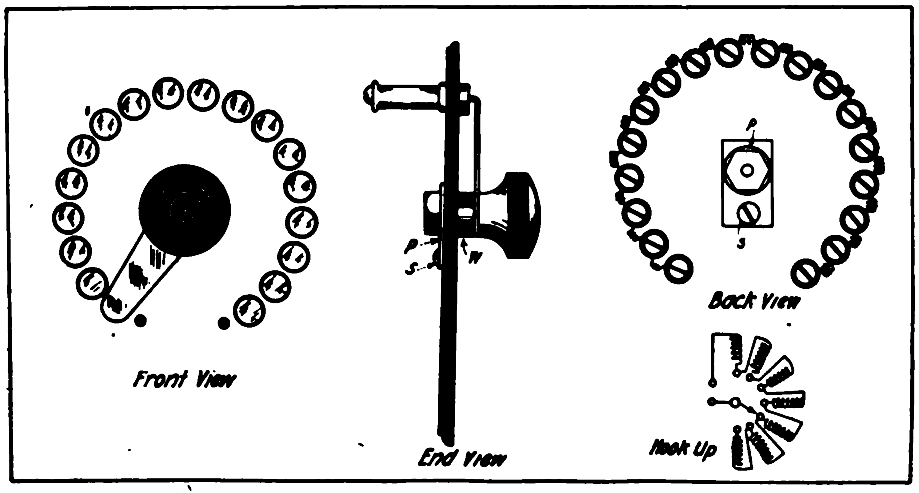
Experimenters' World

A Positive Vacuum Tube Circuit Controller

MANY of our amateurs intend to "be prepared" for the grand opening of stations when Autocracy has been wiped off the face of the earth. They are mentally designing wireless communication sets showing vast improvement over those with which they had previously been acquainted. In designing this "super-set" there is plenty of time to consider each proposed detail very carefully before incorporating it into the design, and it is very evident that this should be done, as raw materials must be conserved for war work and there must be no waste. While on the subject, it might also be suggested that any spare pieces of material, which in peace times would be considered scrap, should be utilized wherever practicable.



Showing construction of the positive vacuum tube circuit controller

In designing the vacuum tube cabinet the amateur is confronted with the conventional porcelain-base rheostat, which, although it is quite acceptable for the ordinary set, would be wholly out of place in an efficient set. In the following paragraphs is described an improvement over the usual rheostat.

For the filament circuit the variable resistance need not be more than 9 ohms, and an eighteen-step variation will be sufficient when a proper circuit is used. The most important part of this controller is the resistance units; those made by the Ward-Leonard Electric Co. of Mount Vernon, N. Y., are preferable. If you order units with a resistance of ½ ohm each then you will know that each step in your controller will cut in ½ ohm resistance and you will be able to make tests for efficiency accordingly.

In most places the accompanying drawings will be found self-explanatory. Perhaps each experimenter has his own method of constructing his switches, but the type in the drawing has proven itself to be efficient and will not unloosen at a crucial moment. It consists of the usual composition knob with a machine screw through the center, over which is put the washer and switch blade; these being fastened in place by the threaded brass washer (W), which is ¼ inch in diameter. The remaining length of machine screw is then run through the carefully drilled hole in the Bakelite-Dilecto panel and a rectangular brass plate (P) put over the screw and is kept from turning by the machine screw (S) which is threaded into the panel. Next, a heavy brass hexagonal nut, ¼ inch thick, is screwed over the machine screw and is kept from turning by a small machine screw which is screwed in a hole drilled and tapped into one of the faces on the edge of the nut.

The resistance units are composed of porcelain tubes wound with a special resistance wire and then covered with vitrified enamel, which completely eliminates oxidization. These tubes are fastened to the inside of the panel by long machine screws passing through the inside of the tubes, passing through the panel, and screwing into the brass switch contact on the other side. A flexible wire tap is placed at each end of the resistance unit. One of these (the one happening to be nearest the head of the machine screw which passes through the tube) is soldered to the head of this machine screw and then brought down to the tap of the neighboring unit which lies nearest the panel, and so on, until all the units are connected in this manner. The best kind of wire for inside connections is rubber-covered stranded wire. All leads should be as short as possible and connections soldered in every case. The connection to the switch arm should be soldered to the brass plate (P).

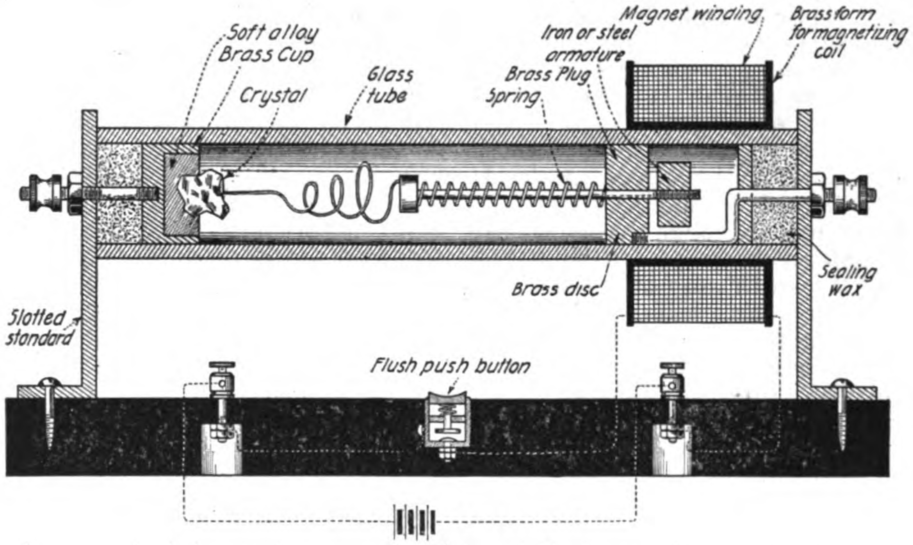
This same idea may be carried out in designing a potentiometer, but the resistance of each unit should be 500 ohms instead of the value of the rheostat units, making 9,000 ohms in all for the potentiometer. Of course the potentiometer must be connected in a different way than the rheostat. A lead must be brought from each end of the arc of switch contacts and another lead from the switch arm. If this design be used for both rheostat and potentiometer on the vacuum tube cabinet a much more uniform appearance will be obtained, due to the fact that each switch has the same outward appearance.

FRANCIS R. PRAY, *Massachusetts.*

Sealed-in Detector With Magnetic Adjustment

INASMUCH as I have never seen this idea suggested before, I venture to present it to the readers of THE WIRELESS AGE, hoping that they may be able to find some interest in the scheme.

The object of the device is to allow both the crystal and contacting means of a mineral detector to be effectually and permanently excluded from the surrounding atmosphere and its deteriorating effects; by modification of the glass container and means of bringing out the connections it may be operated in a vacuum, or even surrounded by various gasses for purposes of experimentation, still permitting the detector to be adjusted as easily as if it were exposed.



A cross sectional view showing construction of the sealed-in detector with magnetic adjustment

The design of the air-tight detector given herewith is intended to be suggestive and not conclusive, as the main idea may be adapted to any form of detector design that will suit the builders' fancy, but this one has considerable merit in its simplicity of construction and operation.

As the cross-sectional view given in the sketch renders the construction and operation quite obvious, only a few words need be added. The mineral cup and metal plug carrying the movable contact should be turned to a snug fit for the inside of the glass tube, and a bit of glue applied before inserting so that they will remain in position without additional holding means. The spring of the movable contact should be relatively light, and its pressure should be adjusted to suit the crystal used before the tube is finally sealed. The armature should be made from a piece of round iron or steel rod. These parts must work free and easy. The binding post terminals of the tube are used to support it by engaging them with two slotted sheet-metal standards fastened to the base. The form for the magnetizing coil should be made of light sheet brass or copper. It must be easily rotated and moved along the tube and may be wound with about No. 22 or No. 24 wire.

A flush push button should be mounted on the base, and connected in series with the coil and battery terminals. This button is depressed while adjusting the detector, and of course the magnetic field is present only while doing so. The magnetic field does not cause any noticeable effect on the rectifying action of the detector.

J. A. WEVER, *Maryland.*

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Improved Code Practice Apparatus

In using the code practice apparatus described by the writer in the February 1918 issue of The Wireless Age, I experienced a "static" annoyance which interfered with the successful operation of this device. The trouble may have been caused by arcing of the brushes on the generator at the power station. The problem was solved by the following changes:

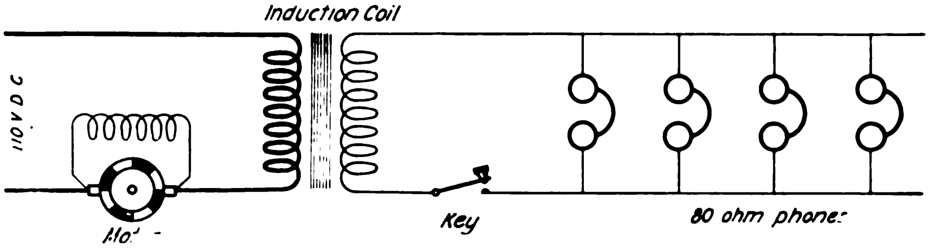


Diagram showing method of connecting the motor with induction coil

In place of the bank of lights, a small motor is connected in series with the primary of the induction coil. The secondary connections are made in the manner described in the February issue.

The accompanying diagram shows how the motor should be connected to the induction coil.

In case it is to be run without load only, a shunt motor should be used. If a small series motor is used a load must be kept on it to keep it from "building up" and finally breaking, either electrically or mechanically. If electric fans are used in the class room the motor of one of these may be connected in series with the coil.

The motor is more economical in use of current than the bank of lights and produces a much more regular sound. As a result of this a class can advance more rapidly than with the irregular type of apparatus used before.

Some radio schools have a system in which a small motor is employed to run a cast iron armature past two magnets, one of which is connected to a low potential source of current, generally a storage battery, while the other is connected to the telephones. For successful operation this type of apparatus requires that the parts be accurately machined and that they run true. The cost of all this work and material amounts to considerable in times when prices are normal, and now it would be very high.

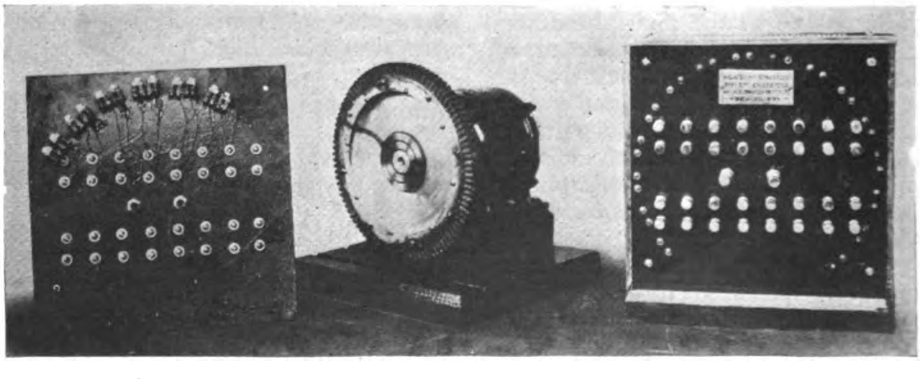
In the other system, with the motor in series with the coil, no machining is necessary, no storage battery is required, and the power from the motor may be used to run the automatic transmitter, a fan or any small device.

On the whole, this system will be found much cheaper to install and same as the more expensive method. to operate and the results will be the

Paul G. Watson, *Pennsylvania.*

Special Code Signal Generator

In the training school for radio operators at the Dunwoody Industrial Institute, Minneapolis, instead of using a buzzer for producing the practice signals in the telephones a high frequency generator is used. This generator has 98 poles and the rotor, which is the field, is revolved at a speed sufficient to give a clear musical note of about 600 cycles. The frequency as well as the strength of the signals can be easily varied so that the students get practice in receiving an exact imitation of the modern radio signals such as are obtained from undamped wave generators and quenched spark sets. The head telephones are connected directly to the stator coils of the generator through the transmitting key. It is driven by a one-sixth horsepower motor.



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THE call for qualified radio instructors during the past month is unprecedented. Schools scattered throughout the country, having taken the responsibility of training several hundred young men for military radio service, ran up against the proposition of locating instructors of experience to direct the training of their student allotment. The Association is, in consequence, in receipt of inquiries from more than a score of schools asking assistance.

In only a few instances have we been able to connect with men of the proper calibre. These have taken up their duties within two or three days from the time of our notification, but there still remain a number of vacancies unfilled.

There is a definite reason for the scarcity of trained radio men. The great majority of those who gained their experience in the amateur field have since gone through a course of intensified training and are now serving in the Army and the Navy. As a matter of fact, of those within draft age, the percentage remaining is almost negligible.

Suggestions for the Experimenters' World

We will pay the usual prizes of $10, $5 and $3, in addition to our regular space rates, to the three contributors who send us the best manuscripts on the following subject:

WHAT IN YOUR OPINION IS THE BEST METHOD TO PURSUE TO PREVENT UNNECESSARY INTERFERENCE IN THE EVERY DAY USE OF WIRELESS TELEGRAPH APPARATUS?

This subject can be treated from both the technical and operating aspects.

Another suggestion:

AFTER THE WAR WHAT IN YOUR OPINION WILL CONSTITUTE THE IDEAL AMATEUR WIRELESS TRANSMITTER AND RECEIVER?

Limit your manuscript to 1.000 words.

It would seem, however, from a broad survey of the field, that there are still some who can carry on this great work of training. Any of our members or friends who feel at all qualified to take such an appointment is urged to communicate with the Association headquarters.

The duties which Uncle Sam requires of instructors for Signal Corps classes do not in every case require the services of a radio engineer; men who have a first rate knowledge of the practical adjustment and operation of radio apparatus will fill the greater need. All must have, however, the ability to teach. In other words, an essential of instructing ability is providing inspiration to listeners, by which they are spurred on to deeper investigation of the subject in hand. Such tutors will fill the bill.

The Signal Corps does not need 100.000 radio engineers. But good, practical operators are wanted—men who can handle the key at 25 words per minute and who can take down a set, reassemble it and adjust it to its maximum efficiency. Out there in the trenches men are required who can concentrate, fellows who make quick decisions in emergencies and "get the business through."

Are any more of our readers fitted to become wireless instructors? We'd like to hear from them. They will do our country an essential service. Nothing is more important in this great war than the services of a skilled worker. And few needs are more pressing than the call for radio instructors.

The Association has discovered a humorist in its ranks. Deference to his professional standing restrains us from publishing his name,

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but here is his plea: "I never knew until recently that my cosmic existence was so bound with electrons; and am I to assume, from the explanations that some of you scientific gents are putting forth at headquarters, that my personal atomic structure is basically electrical? Come out and be honest with we oldtimers—we want facts."

Facts!! Nothing easier, or more agreeable, we reply. We've always liked facts, and factors. Thrive on 'em, in fact. Which is a fact—absolutely. So, for fact Number One, dear sir, it should be recorded that the classification of atomic structures these days is determined by local draft boards. Moreover, with a normal congregation of atoms there will be no detectable manifestation of electrons or any other type of ethereal radiations.

It is sadly evident that you have not yet grasped the fundamentals underlying the structure of matter as agreed upon by authorities. But intelligible, so to speak, thought wave trains are occasionally permitted to emanate from the headquarters tower of erudition. Without fear of the law, therefore, you may listen in this time; and if you can—

Follow this . . . Experiment and reasoning point to the fact that a normal atom is made up of a distinct number of electrons joined to a positively charged nucleus of atomic dimensions, and a state of electrical balance thus exists which gives no external electrical manifestation.

Are you listening—carefully?

Suppose we drive an electron from an atom, what happens? The balance is destroyed. The unfortunate atom is minus an electron, and it therefore possesses an excess of positive electricity. It has been proven (over and over again) that the detached electron is negative electricity, and it is thoroughly believed that the so-called flow of an electrical current in a conductor is nothing more than the movement of electrons; that is, it is a movement of negative electricity from a negative source towards the positive terminal.

We never have positive electricity in a free state. It is always hooked up with matter in some way or another, in so far as we know. An electron, on the other hand, can exist independently of matter or in association with atoms or molecules.

Conductors of electricity such as metals are composed of free electrons which move among the assemblage of atoms at a normally slow rate. An electric force applied to the conductor will drive these electrons from the negative to the positive direction at the normal velocity of electricity—you know, 186,000 miles per second. If the applied electromotive force is great enough, the free electrons in the conductor will collide with the atoms, and produce heat. We ordinarily call this heat production electrical resistance.

Insulators or dielectrics, on the other hand, are assumed to possess no free electrons, therefore they cannot pass the flow of current in the ordinarily accepted sense; in fact, in order to detach electrons from insulators, we must, for example, pierce them with an electrical spark. We thus tear sufficient electrons out of the structure to cause a breakdown, and ionization takes place, resulting in the phenomenon of heat and light. In plain words, electrons are imprisoned in insulators and we can only remove them by disrupting the atomic structure.

In summary: Add an electron to a normal atom and you will have a negatively charged body. Take an electron away from a normal atom and you will have a positively charged body.

It follows, therefore, dear Sir, that your existence is basically electrical. Not insofar as appearances are concerned, for you are of atomic dimensions. But if you have lived a normal life—a life made up of a vaguely defined amount of positively charged nuclei (whatever they are) surrounded by the correct number of electrons to effect a balance—you are just an ordinary everyday normal atom.

You undoubtedly possess a number of free electrons in your physical makeup. These are easily set in motion. Grasp in each hand the terminals of a 60,000-volt transformer. The ordinary slow-moving free electron which travels to and fro in your body at a rate of about 60 miles per second will suddenly rush forward at a speed of 186,000 miles per second.

Disruption of the atomic structure may ensue.

But that is science.

And though here at headquarters we greet the frankly curious many times, yet—as originally noted—we are ever eagerly inclined to standing by the facts in our statements.

Come again.

Chats With Our Contribs

Should the author of a work of fiction expose the plot of his story in the first paragraph, you would probably seek to establish contact with his intellect with an armful of bricks. You expect to twist and tangle in a mental labyrinth of startling experiences, the outcome of which can not be conjectured by the keenest imagination. And you don't expect the climax till the last chapter—which accounts for our lady fiction fiends reading the last three pages first.

Apropos of which Assn. Hdq. wishes to officially announce that our organ, the AGE, is designed for masculine consumption; i. e., minus the "surprise" ending—and strictly non-fiction in composition. Whereas some of our contribs eternally try to surprise us with technical articles prepared a la novelist. It's a regular thing to find in the mail a technical article with the plot exposed in the last paragraph. It won't do, worthy scribes. Readers of this magazine naturally want to know, first, what your story is all about. And they're right.

It couldn't be expected, for instance, that an architect who designed a house supplied the builder first with a description and drawing of a window, then of a joist, next of a sill, then of a doorstep, and so on, without extending the faintest idea of what the final appearance of the house was going to be. The builder naturally requires first some idea of the general plan and the objects of the design.

And so it is with technical MSS. Many of our contribs hand us a long, uninteresting story of the construction of minor details, without giving the faintest idea of what the object of the apparatus is until the last paragraph is reached. This requires an extra effort to grab the verbiage bull by the horns and turn him around the other way.

What are we grumbling about? The way in which some of you fellows with basically good ideas in your craniums twist them reduces the article to the status of a Chinese puzzle for our scrutiny.

If you offer us the design of some new piece of amateur radio apparatus, it must have some particular use. All right, then state the object of it in a broad, general way. Then point out the fundamental parts of which it is composed. Next state briefly its operation and then go into the details. Follow this by a concise statement of the results secured in practice.

This is the standard form which all our contribs should follow. It doesn't mean adopting standardized forms of expression, however. We want your story to be natural, but constructed with some sense of order.

We can use a great many manuscripts on general technical subjects. Particularly articles bearing upon the construction of experimental apparatus. Descriptions of new inventions, too, accompanied by first-class photographs will be paid for at regular space rates.

You must have noticed from last month's issue that a very large majority of those in the radio fraternity are under instruction either in the Army or Navy. The figures run up into thousands. They are helping to solve one of the greatest problems the Government had to face. It was soon found that a picked set of men were required to operate complicated apparatus of modern telegraph equipment.

Men in the service cannot, of course, write for publication without permission from superior officers, but we believe that many experiences which raw recruits have undergone at these radio schools would prove of great interest to our readers. These fellows should get busy—take pen in hand, and all that. Routing the product: MSS., superior officer, us. We can handle a lot of these articles.

Queries Answered

Answers will be given in this department to questions of subscribers, covering the full range of wireless subjects, but only those which relate to the technical phases of the art and which are of general interest to readers will be published here. The subscriber's name and address must be given in all letters and only one side of the paper written on; where diagrams are necessary they must be on a separate sheet and drawn with India ink. Not more than five questions of one reader can be answered in the same issue. To receive attention these rules must be rigidly observed.

Positively no Questions Answered by Mail.

A. B. S., Cleveland, Ohio:

The speed at which a synchronous motor will run when connected to an alternator supplying current at a given frequency may be determined as follows:

$$S = \frac{2 \times f \times 60}{P}$$

when S = the revolution of the armature per minute, f = frequency of the supply current, P = number of poles in the motor field.

A ten-pole motor, for example, would run 720 revolutions per minute.

Replying to your second query, synchronous motors possess several disadvantages, among which may be mentioned that they are not adapted to variable speed; they possess a small starting torque; they require an outside exciting current and very skillful attention during operation.

Replying to your third query, the synchronous motor adjusts itself to variable loads by the change of phase difference between the armature current and the applied E. M. F. This is too comprehensive a subject to be discussed here; an explanation will be found in any textbook of alternating current engineering.

* * *

D. M. A., Washington, D. C.:

The inductance of a dynamo armature may be obtained by sending through it when at rest a measured alternating current simultaneously measuring the E. M. F. between the collector rings. The following formula then applies:

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$$E = I \sqrt{R^2 + (2\pi N)^2 L^2}$$

or

$$L = \frac{1}{I^2 \pi N} \sqrt{E^2 - (I R)^2}$$

If the armature resistance R and the frequency N are known, the foregoing formula will give the desired result. Be sure and take into consideration that the value of L varies largely with the position of the armature in respect to the field poles. The reason is, of course, obvious.

* * *

H. R. T., Sydney, N. S. W.:

Your queries in regard to armature reaction in an alternator will be found answered in any text-book devoted to alternating current engineering.

When the armature current of an alternator is in phase with E.M.F., the armature reaction is negligible and the field flux therefore remains practically constant. On the other hand, a lagging armature current opposes the magnetizing action of the field coils, whereas a leading current assists the magnetization of the field poles.

Obviously an alternating current circuit of high self-inductance will tend to decrease the voltage of the alternator.

* * *

L. W. Seattle, Wash.:

A graphite rod of approximately 2,000 ohms will give the required resistance to be placed in series with your 400-ohm potentiometer.

* * *

G. C. H., Fort Stockton, Tex.:

In the wiring up of a vacuum tube panel receiving set, care should be taken to run the grid and plate circuit wires as far from one another as possible, and preferably at right angles. The two secondary terminals of the receiving transformer should be fairly well separated or otherwise they would add a shunt capacity of considerable value to the secondary circuit.

You can readily see that if the grid and plate circuit wires are placed in inductive relation, a certain amount of regenerative coupling will be obtained which may not be desirable in the circuit you have under consideration. It is not necessary to go to extremes in this matter, but it is well to take a certain amount of precaution.

We would not advise the use of an ordinary plug strap switch board for experimenting with different circuits for the reason that the parallel conductors of the plug cords possess a considerable amount of capacity between wires. This may upset the working of certain circuits.

Replying to your third query, it will not harm matters to bring the taps from the primary and secondary coils of the receiving tuner through the inside of the tube. It would be well, however, not to make them of inordinate length.

* * *

S. F. McC., Mercer, Pa.:

Ques.—(1) If a receiving set is constructed so that the inductance can be varied one turn at a time, is it ever necessary to employ a variometer?

Ans.—(1) A single turn multi-point switch will give all the regulation required. In event, however, that a single turn switch is not provided, the variometer will be found useful.

* * *

R. D. L.:

Ques.—(1) Are there any opportunities open for qualified wireless telegrapher experimenters to train students in either the Army or Navy? What are the chances of securing such employment and would a first-class amateur experience aid the applicant in securing recognition?

Ans.—(1) We believe that the amateur's experience in manipulating experimental wireless apparatus has secured just recognition on the part of the Government. A radio engineer in charge of a large Government radio school states that the students who were formerly amateurs made by far the most rapid progress. He found it rather difficult to teach men who have not had such experience to manipulate radio apparatus to secure the best results.

We are informed by the directors of the Marconi Institute that they are in receipt of numerous inquiries from colleges and universities throughout the United States for the services of radio instructors to train men in the Students' Army Training Corps. If any who have had commercial or amateur experience believe themselves qualified to carry on such work they should communicate with the editorial office of this magazine. Recommendations to the proper parties will be made.

* * *

T. D. L., Denver, Col.:

We understand that radio students at Great Lakes, Ill., after they obtain a certain ability in the International telegraph code are transferred to the classes of Harvard University. If they pass the examinations at this institution they are assigned to land stations, aviation camps or battleships. The greater proportion of assignments are made to the fleet.

In reply to your second inquiry, we understand that promotions from third-class electrician up to the appointments of chiefs are judged from the results of technical examinations given from time to time to those of proper qualifications.

A chief electrician should have a general all-around knowledge of wireless transmitters and receivers. He should be able to make elementary calculations on oscillation circuits. It is a foregone conclusion that he will have knowledge of tuning by means of a wave meter and measurement of the logarithmic decrement. Graduates of the Naval schools are expected to transmit and receive at a speed of 25 words per minute.

* * *

A. B. D., Cleveland, Ohio:

Ques.—(1) How can one enroll in the Students' Army Training Corps?

Ans.—(1) It is our understanding that if a man coming within draft age is already a pupil of a properly appointed Government training school, he will be permitted to remain and complete his course if the course he is taking is of value to the Government in prosecution of the war. On the other hand, those who are not in attendance at colleges or universities are selected according to the number of vacancies in the Students' Army Training Corps, application being made through local draft boards.

This is not official information, but it seems to be the general procedure followed in New York.

Newspaper reports have it that the Navy will open enlistments for 15,000 men per month from the various draft boards.

In reply to your third query, we believe that your knowledge of radio telegraphy will receive consideration from the Government after you have been called to service or permitted to enlist. As you will note from the draft questionnaire a thorough classification of all selected men is to be made.

Book Reviews

Above the Battle. By Capt. Vivian Drake, R. A. F. Cloth binding, 5x7½ inches, 323 pages. Appleton. Price $1.50 net.

The candidate for military aviation honors seems to have been particularly in the mind of the author while writing this book. The viewpoint is British, and the places and machines dealt with are English in substance, yet the spirit of aviation training has been caught with universality of understanding, and incidentally set down with many a whimsical touch to lend charm to semi-technical descriptive passages. When the training chapters are passed and the voyage overseas begun, the reader views the proceeding with a tinge of regret. So graphic has been Capt. Drake's descriptions of sensations in first flights that it is natural to wish for more. But equally important phases of flying are later included and described with quite as much skill. Bombing raids and night flights, artillery control, the day's work—in fact one chapter is so called—all are interestingly told in an easy conversational style. Readers who care for a little extra substance with an amiable descriptive method will be pleased with this book.

Obtainable through the Book Dept., The Wireless Age.

High Adventure. By James Norman Hall. Cloth binding, 5x7½ inches, 237 pages. Houghton Mifflin. Price $1.50 net.

Cavalry of the Clouds. By Capt. Alan Bott. Cloth binding, 5x7½ inches, 266 pages. Doubleday, Page. Price $1.50 net.

Knights of the Air. By Lieut. Bennett A. Molter. Cloth binding, 5x7½ inches, 243 pages. Appleton. Price $1.50 net.

The three books listed above are of similar type, all personal narratives and dealing broadly with military aviation in somewhat the same manner as the two narrative volumes just reviewed. In full justice to all, it must be said that they are unusually well written and leave little upon which to base a preference for the reader. In view of which, and since the main purpose of a book review is to aid readers to a decision as to whether or not they wish to secure the volume, the only real distinction must remain in subject, rather than composition.

Mr. Hall bases his incidents and anecdotes on the Lafayette Escadrille and its members.

Captain Bott glimpses the early war work of the Royal Flying Corps in France.

Lieutenant Molter does not limit himself to his unit, Escadrille N-102, but includes rather broad observations of facts and methods, with less emphasis upon experiences.

All three books obtainable through the Book Dept., The Wireless Age.

Traveling Under Orders. By Major William E. Dunn. Cloth binding, 4½x6 inches, 80 pages. Harper. Price 50 cents net.

This volume is one of those supplementary texts for Army officers that take up the very details which govern recognition of an organization commander as a mediocre or successful leader of troops. Drill manuals and field service texts give, so to speak, only the rules of command. Major Dunn's little book takes hold of the unwritten rules which have recently been required by the problem of moving a battery from a cantonment here to the front in France. The small things that are supposedly learned only by experience are particular subjects for his discussion. This item, for example, will be greeted with a reminiscent grin by every officer who has once entrained his command: "Trucks are obtained from a quartermaster to haul the property from the camps to the train. After a certain number of trucks have been assigned to an organization, a non-commissioned officer must be detailed to remain permanently with each truck, both in going to and returning from the train. Otherwise, an organization commander will soon find his trucks busily engaged in hauling for other outfits." Equally pertinent is the warning that the train conductor and Pullman conductor check their account with that of the organization, and if a few extra vacant berths are occupied by the men for their additional comfort, a letter will eventually come from the War Department to the commander, "requesting him to explain why a charge for the same should not be deducted from his pay." Tips like these appear on nearly every page, outlining the journey by sea, arrival in France and quartering at the training camp, marching to the front, billeting and arrival on the firing line. Certain it is that an officer cannot make a better 50-cent investment than in procuring a copy of this little volume prior to departure overseas.

Obtainable through the Book Dept., The Wireless Age.

The Koehler Method of Physical Drill. By Capt. William H. Wilbur. Cloth binding, 4¼x6 inches, 149 pages. Lippincott. Price $1.00 net.

Every American knows and admires what is recognized as the West Point carriage. It is distinctive and more than ordinarily graceful—and exceedingly difficult of imitation. The reason for this is perfectly clear to the initiated, for the set of our cadets' heads and shoulders, swinging stride and easy position of arms are the direct result of a method of physical training that is quite as distinctive as the result it secures. To Major Koehler entire credit is due for this physical drill, and to application of its principles the text of the present volume is devoted. In the hands of the author, Captain Wilbur, the explanations reflect the Koehler personality which has contributed so greatly to his success. Captain Wilbur has been his assistant at West Point and special instructor at Plattsburg, and he manages to convey in the pages that running exhortation to special effort which in the Army is universally known as "boning Koehler." As an instance, in the breathing exercises we find the interpolating directions: "Fill them up! On your toes! S-t-r-e-t-c-h!! Come on!" And again, in counting: "one, two, three, four—mark, each, position, four—one, two, three, four—hold, your heads, up four," or for individual correction: "one, two—one, Brown—up on your t-o-e-s, two—one, two—one, that's right—one, two," etc.

Thus in this small volume the reader is given not only the exercises well illustrated by photographs, but clearly indicates how the instructor may make the men feel that these physical drills are helping to make their particular organization the best in the army. The advance in physical drill which marked the advent of Major Koehler's method, being perpetuated in this small volume, makes the contribution of its author of very material value in building up men physically and working them up mentally.

Obtainable through the Book Dept., The Wireless Age.

En l'air! (In the Air). By Lieut. Bert Hall. Cloth binding, 5x7½ inches, 153 pages. New Library. Price $1.65 net.

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the command given French aviators to leave the ground on a mission, is the personal narrative of one among the first of Americans living in France to enlist at the outbreak of the war. This group, thinking a country good enough to live in was good enough to fight for, were first to the trenches with the Foreign Legion. Experiences there are briefly covered and then the balance of the book is devoted to aviation training and various episodes of war combat. Lieut. Hall's story is really an informal record of the now famous Lafayette Escadrille; the reader is introduced to the original ten American members and learns of their exploits and methods of attack.

Obtainable through the Book Dept., The Wireless Age.

Glorious Exploits of the Air. By Edgar Middleton. Cloth binding, 5x7½ inches, 256 pages. Appleton. Price $1.35 net.

By numerous anecdotes and comments on branches of the air service, Mr. Middleton has gathered into his volume a neat collection of human interest documents dealing with aviation in war time. The necessity, or supposed need, for designating the men as X, Y, or Z, instead of giving their real names is unfortunate, but in spite of this handicap the exploits in themselves are so dramatic, and in character so heroic, that the aviator stands forth as a distinct type of warrior, resourceful and agile-minded, brave and with high principles of honor. For an evening's entertainment, no better book of its kind could be found.

Obtainable through the Book Dept., The Wireless Age.

Glossary of Aviation Terms, English-French. Compiled by Capt. Victor W. Pagé and Lieut. Paul Montariol. Stiff boards, 5x7½ inches, 94 pages. Henley. Price $1.00 net.

This booklet does not give definitions of terms, but supplies the French equivalents for a list which is divided into four parts, namely, flying field, the plane, the engine, tools and shop. Fourteen illustrations are included, the parts of the apparatus shown in each being clearly lettered with the French term above a line under which the English designation is given. The book is intended only for use of those already familiar with aviation.

Obtainable through the Book Dept., The Wireless Age.

A French-English Military Technical Dictionary. By Col. De Witt Willcox, U. S. A. Cloth binding, 6¼x9¼ inches, 584 pages. Harper. Price $4.00 net.

Colonel Willcox's standard work appears in 1918 dress with nearly a hundred added pages to include all the new technical nomenclature of aviation and trench warfare. Even military slang and the special modern terms of the artillery and the camouflage corps appear, bringing the dictionary literally up to date. Its compiler's position as Professor of Modern Languages at West Point has given him unusual opportunities to collect the new words from reading official and standard texts. Thus for the officer about to engage in overseas service it may well prove an invaluable aid should he be assigned in time to liaison duty.

Obtainable through the Book Dept., The Wireless Age.

Fundamentals of Naval Service. By Commander Yates Stirling, U. S. N. Cloth binding, 4½x7 inches, 589 pages. Lippincott. Price $2.00 net.

Civilians in the draft who purpose arranging for induction into the Navy will find in this volume an exceptionally broad and practical explanation of the workings of all parts of naval ships and the duties of the various classes of personnel. It is a condensation in very readable form of an immense amount of official material from the Navy Department and a thoughtful abstract of the best essays on sea strategy.

Past and present naval policy is reviewed, principles of strategy given, and traditions, training, honors and distinctions explained. The evolution of the modern dreadnaught is traced and all types of battle craft described. Organization and administration of the department and a warship at sea is contained in a separate section. Seamanship, navigation, construction and ordnance lead up to a careful explanation of the multitudinous uses of electricity and the many engineering branches which comprise the naval establishment. Naval aviation is also dealt with, and the personal aspects broadened to include a survey of the navy as a career and the soldierly duties of the sailor. Even first aid and hygiene are listed among the subjects contained between the covers of this veritable "bible" of naval affairs.

It may be said without reservation that Commander Sterling has produced a notable contribution to naval literature in this handbook.

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STATEMENT OF THE OWNERSHIP, MANAGEMENT, CIRCULATION, ETC., REQUIRED BY THE ACT OF CONGRESS OF AUGUST 24, 1912.

Of The Wireless Age, published monthly at New York, N. Y., for Oct. 1, 1918.

State of New York. }
County of New York. } ss.

Before me, a Notary Public in and for the State and county aforesaid, personally appeared E. J. Nally, who, having been duly sworn according to law, deposes and says that he is the President of Wireless Press, Inc., publisher of The Wireless Age, and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management, etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, embodied in section 443, Postal Laws and Regulations, to wit:

1. That the names and addresses of the publisher, editor, managing editor, and business managers are.

Publisher, Wireless Press, Inc., 25 Elm St., New York, N. Y.
Editor, J. Andrew White, 25 Elm St., New York, N. Y.
Managing Editor, None.
Business Manager, Alonzo Fogal, Jr., 25 Elm St., New York, N. Y.

2. That the owners are: (Give names and addresses of individual owners, or, if a corporation, give its name and the names and addresses of stockholders owning or holding 1 per cent or more of the total amount of stock.)

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3. That the known bondholders, mortgagees, and other security holders owning or holding 1 per cent or more of total amount of bonds, mortgages, or other securities are: (If there are none, so state.) None.

4. That the two paragraphs next above, giving the names of the owners, stockholders, and security holders, if any, contain not only the list of stockholders and security holders as they appear upon the books of the company but also, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting, is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner; and this affiant has no reason to believe that any other person, association, or corporation has any interest direct or indirect in the said stock, bonds, or other securities than as so stated by him.

E. J. NALLY,
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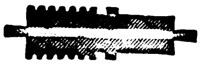
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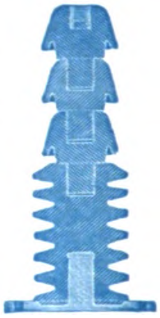
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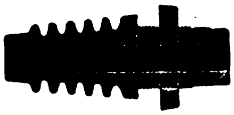
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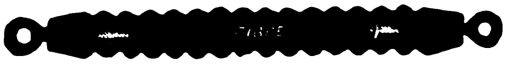
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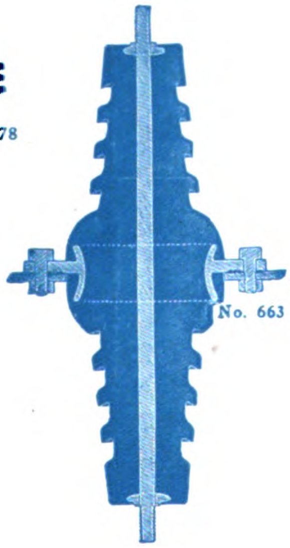
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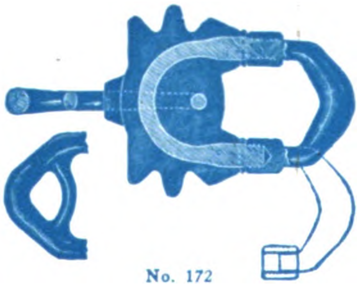
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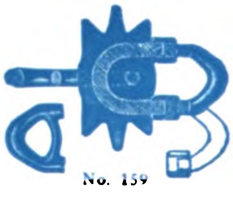
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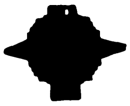
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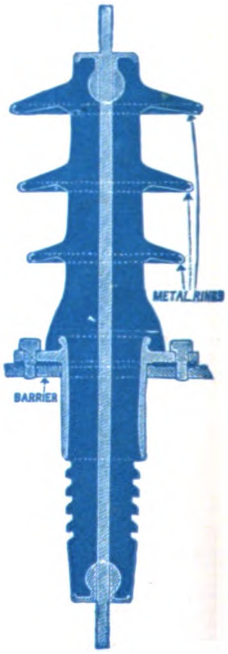

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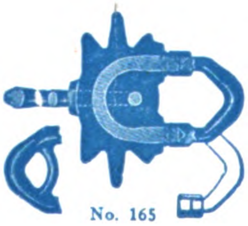
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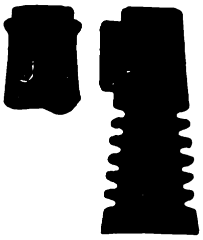
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The Wireless Age

Edited by J. ANDREW WHITE
E. E. Bucher, Technical Editor.

Vol. 6 No. 3

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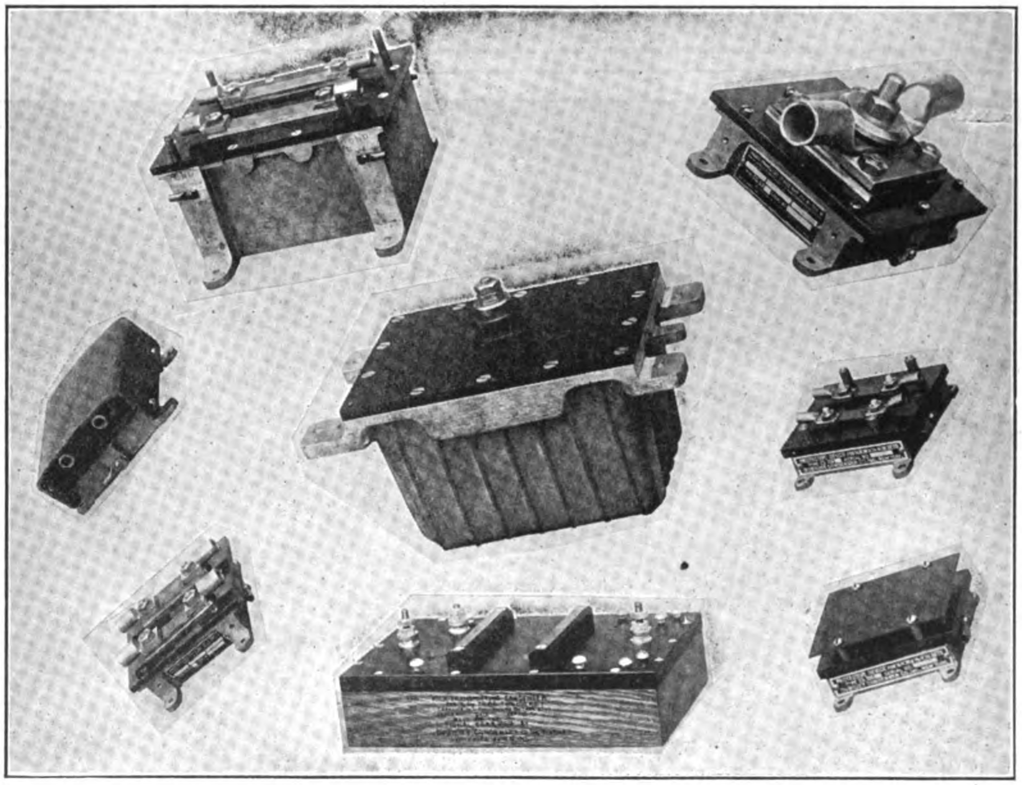

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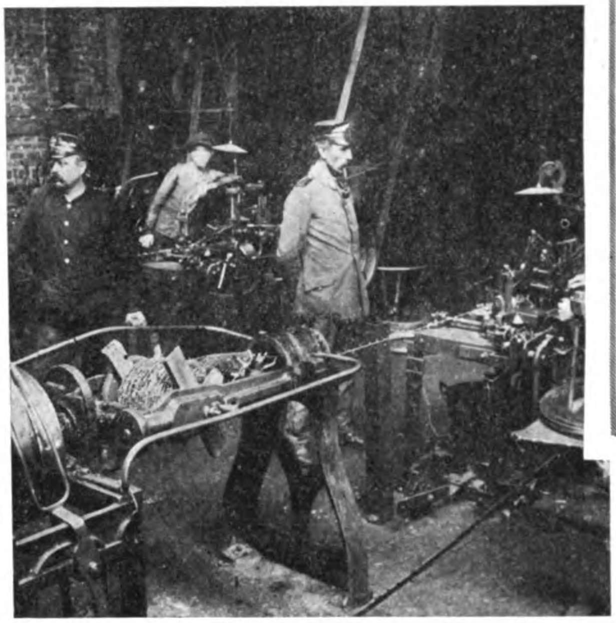


That thousands of racks like those shown above and miles of barbed wire must be removed from France and Belgium is but one of the reconstruction problems facing the Allied armies

It is a safe assumption that shops such as shown at the left may be put to uses other than manufacturing the wire entanglements which have up to now been of so material a factor in warfare

When trees were felled to block a canal their removal by the enemy was impeded by weaving the wire through the branches

Vol. 6. No. 3. DECEMBER, 1918

THE WIRELESS AGE

WORLD WIDE WIRELESS

Airplanes Directed By Wireless Phone

SQUADRONS of American airplanes fighting in France up to the moment of the armistice were maneuvering under the vocal orders of the squadron commander that reached each pilot by radio telephone.

News of the successful development of this device, hitherto a military secret, though some inkling of it had reached the Germans just before hostilities ceased, is now allowed to become public by John D. Ryan, director of aircraft production.

"There are some details concerning it which we cannot discuss yet," Mr. Ryan said, "but the radio devices worked out during months of experiment went into actual service some weeks ago. I have myself, standing on the ground, given orders to a squadron flying in the air and watched them maneuver accordingly. The transmission of the voice is clear enough to be heard distinctly through the sound of the airplane motor. It is in every way the most satisfactory means of communicating between planes in the air and from the ground to planes."

Mr. Ryan said he could not discuss the distances over which the radio telephone has worked, but it is known to be a matter of some miles.

W. C. Potter, of the equipment division of the bureau, explained that the idea of the radio telephone was conceived some time ago by a number of experimenters.

"For some months it has been possible in our offices in Washington to hear the airplanes flying miles over the city," he said, "talking to each other and to the ground as they worked out and perfected the device."

Loan to China Arranged by Marconi Co.

BANKERS interested in the proposed international loan to China said that the Chinese loan of £600,000 which London cables report will be offered there soon at 105 has no bearing on the Five Power Loan in which the United States probably will participate. It is merely a local loan arranged by the English Marconi Wireless Company in connection with the installation of wireless apparatus in China. The Five Power Loan still is in the diplomatic stage.

The issue arranged by the Marconi Company has been sanctioned by the British Treasury and Foreign Office, it is reported.

The Chinese Government has signed a contract with the Marconi Company for the construction of three wireless stations at Kashgar and Urumchi, in the province of Sinkiang, near the Turkestan border, and at Lan Chow Fu, capital of Kansu province, in central China.

A smaller station will be erected at Sian Fu, in Shensi province. These stations will establish communication between Kashgar and Pekin. They will be of greater transmitting power than any others in China.

Five New Stations for Philippines

THE Philippine Government has released an appropriation of $37,500 for the erection of a wireless station in Manila. Other appropriations provide for stations at Cebu, Bongao, Puerto Princess and San José, Mindoro.

Kirby in N. Y. World
"You Held Fast and We Won"

Institute Wireless for Forest Fire Emergency

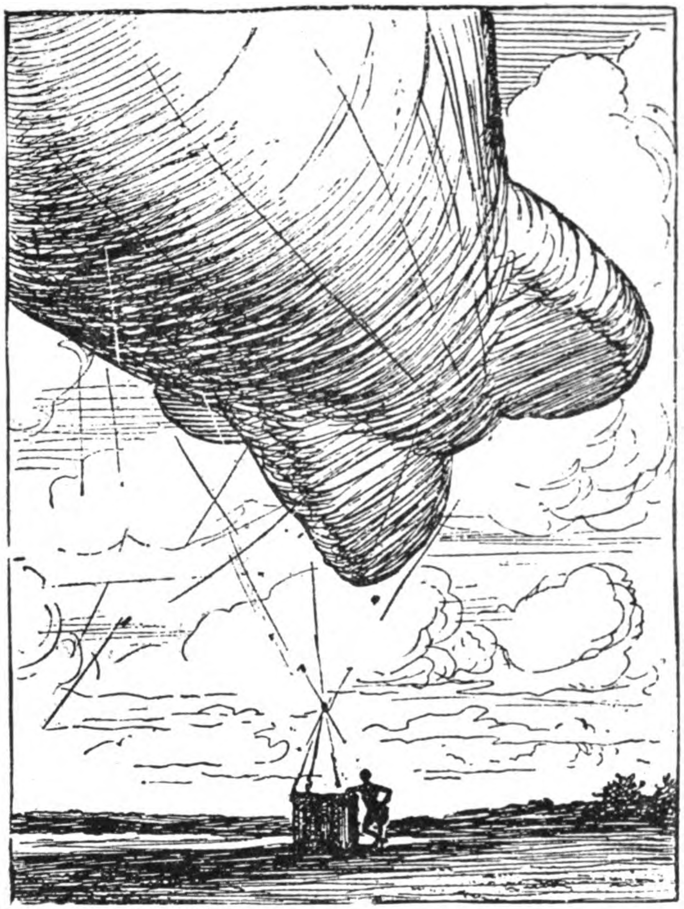
DUNWOODY INSTITUTE, Minneapolis, on October 13th, volunteered the use of its wireless plant in maintaining communication with Duluth, should other sources be broken by the forest fires. Dunwoody has the only authorized radio plant in the state, except the Government station at Duluth. It has been able to maintain the station only through the fact that naval operators have been trained at the institute.

H. W. Kavel, acting director of Dunwoody, when informed of the possibility of the loss of other sources of communication with Duluth, promptly proffered use of the station, if it be needed.

"Although we have no authority for using our plant in this kind of work," he said at the time, "loss of other communication would constitute an emergency for which, I believe, we would have no difficulty in obtaining permission to use it."

Report That Holland Contracted for German Station

LITTLE comment has been aroused by the report that Germany contracted for a wireless station in Holland less than two months ago. The radio profession is, however, extremely interested in the dispatch which was cabled to the Christian Science Monitor on October 12th announcing a Berlin message which stated that the Dutch Government concluded an agreement with the German Telefunken Gesellschaft, empowering the latter to build a wireless station at Kootwijk in Holland, of the same power as the Nauen station, to enable Holland to hold wireless communication with North and South America, and the Dutch East Indies.



From Punch (c) London

Sent in reply to the following request: "Darling, do send me a picture of yourself standing by the machine you fly in"

Enemy Submarines Radio Weather Reports

IN connection with the work of the German Army Meteorological Service, it has, since the beginning of the war, been a matter of some interest to know how the enemy obtained the observations, especially from the western coast of Ireland, which are very necessary in constructing weather maps and in making forecasts. Captured documents show that their meteorological reports were fairly complete, despite the fact that no publication of weather data or forecasts were permitted in English newspapers. An English meteorological expert declares that the answer to the question is not through any system of spies and land wireless, but that the data were obtained from observations taken by submarines. He thinks that a submarine working off the western Irish coast was detailed to send weather reports to Germany by relays through the wireless apparatus working around the British Isles.

Sites for Japanese Station Decided

ACCORDING to the Japanese department of communications, the new duplex wireless station, the construction of which this magazine predicted in the October issue, is to be built in Fukushima prefecture and will cost 860,000 yen ($430,000). The transmitting station will be at Hibarigahara, near Haria-machi, and the receiving station will be at Hosoya-cho. Survey work has been started by engineers of the department. The direct distance between the new office and San Francisco is 4,600 miles, while that between the Funabashi office and Honolulu is 3,250 miles. Service will not be opened for two years.

Ship's Radio to Report Gulf and Coast Weather

"IF VESSELS of any size at sea and plying the gulf had necessary wireless instruments so as to notify the weather bureau stations of weather conditions it would be a great benefit in forecasts," is the opinion of Meteorologist W. J. Bennett of Tampa, Fla. "Had such been the case and if war conditions permitted boats to be stationed at certain points, warnings of such disturbances as the Clearwater and west coast storm would be forecasted in time for an advisory," he adds.

"The hurricane or series of tornadoes which apparently originated in the central section of the gulf was the first storm of any intensity to occur in years of which no warnings were given. It is possible that warnings were sent to Washington of this storm but it was too late for advisories to be given out," he explains.

Mr. Bennett thinks that with the war over the Government may take some action in putting vessels with wireless equipment at such points that advices may be sent by wireless to the weather department in Washington in time for warnings.

Secret Wireless Station Helped French

SINCE the armistice brought hostilities to an end it has been learned that the morale of the population of Lille was maintained by news given from a French wireless station hidden from the Germans. Good news spread quickly through underground channels. The people knew that 10,000 American soldiers were arriving daily. Airplanes also dropped many leaflets, which were eagerly taken despite German efforts to prevent their distribution.

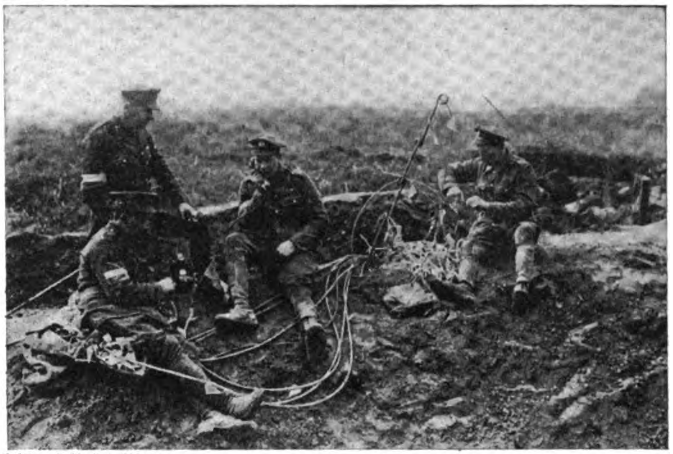
Constabulary Seize Unsealed Set

AFTER troopers of the State Constabulary had maintained a vigil three nights outside the home of Christian H. Siebs in Spring Valley, N. Y., where they discovered a wireless telegraph station, Lieut. John Walton seized the apparatus on October 17th.

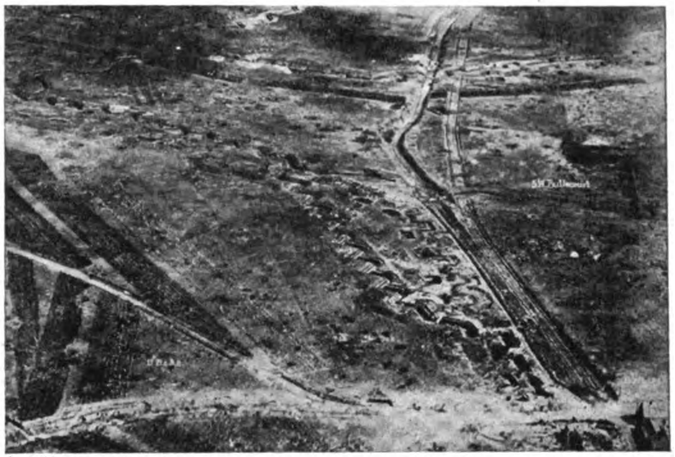
Police and military authorities long have been trying to trace mysterious signals and surreptitious wireless outfits in the hills of Rockland County. Recently, through Major Ord of West Point, signallers were warned they would be shot.

Lieut. Walton found the set dismantled but in such shape it could be very quickly set up and operated. It had never been sealed, as the Federal law requires, the police allege.

No further action will be taken, it is announced, as there was no evidence that the apparatus had been in use for several months, and that the only complaint against Siebs was that the apparatus was not sealed, as required by Federal regulations.


British Official Photo

Perfection of signaling systems using sound and light has been one of the principal achievements of American physicists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A trench system like this, a view of the Hindenburg Line, became possible only through the help of the geologist

How Science Beat the Hun

The Accomplishments of the Trained Man of Science in the War *

By J. S. Ames
Professor, Johns Hopkins University

I THINK it is only fair to say that the universities of this country have played their part well. Before we actually entered this war, in those anxious years when we were waiting to see whether we would be given an opportunity to join in the fight for the cause of honor, freedom and the teachings of Christianity, or whether we must walk through the years of our lives with heads hung in disgrace, no group of people did as much to hold aloft the illuminating torch revealing the iniquity of the enemy of civilization, as did the presidents of our universities. Theirs will be the honor forever. They would not keep silent. Then, as soon as we were by official act in a state of war, the first to step forward and say "use me" were the faculties and the student bodies. It was indeed a sight which brought tears to the eyes, and even further, to see our young men, the chosen men of our land, struggle against all restraints, eager to bring to an end that evil thing which threatened to destroy all the joy of life, all that made life worth living. Every teacher has felt thrilled by the daily farewells of his students, as one by one has obtained permission, by fair means or otherwise, to enlist in the grand adventure.

It is the privilege of being a young man today, a college man or not, to be a soldier in the cause of civilization and to help bring victory to its colors; and what a glorious privilege this is! But upon whom rests the duty of interpreting events and their causes in language so clear that every man understands? Surely, upon the university man. And, when victory is won and men can give their minds to thoughts of safeguarding the world, there is no one to guide them but the students of history and of political science.

It would be a simple matter to show how a special and particular responsibility has already come to and will continue to remain with each and every university group of scholars. I can speak with more definite knowledge of the relation borne by various branches of science with the war; and it is to this feature that I shall confine myself.

A recent writer has alleged that the study of science at the expense of morals in German universities has led to this war.

This is a bitter charge, but it is supported only by fallacies. Macaulay, in his brilliant essay on Dryden, shows, by a series of striking illustrations, how little is the influence upon the age of any individual, or any special group of individuals, when compared with the influence of the age on the man or group. When the time is ripe, the idea is born; the special man who reveals it is immaterial.

So it is today, no one man, no particular department of thought or study can be held responsible for the present conditions in Europe.

It is no more fair to say that the pursuit of science perverts character than to assert that the study of morals results in ennobling it. This war is due to a gradual debasement of character and nothing else, and the cause is to be sought in the will of the leaders of Germany.

One reason why science has been thought of as the scapegoat is because it was so evident from the very beginning of the war that Germany had mobilized for the purpose of war all her men of science, and was using the fruits of their investigations in ways entirely unexpected. This was a matter of great surprise to most Americans, and illustrates clearly the comparatively insignificant position held by scientific men in the minds of our people.

This feature of Germany's long preparation for war, and of her manner of waging it was recognized instantly; and preparations to combat it were made promptly by all the allied peoples. Fortunately for us, the essential advantages were all with the French and British, inasmuch as their men of science had for nearly a generation been the ones who had given to the world its great discoveries and their most important applications. So their scientists came to the problems with ideas and methods which in many cases far surpassed the power of Germany to equal. The result was instantaneous; and today the efficiency of the forces of the Allies on the sea, on the land and in the air is due in no small degree to the men whose previous lives had been devoted to the pursuit of the pure sciences in university laboratories.

When this country entered the war, it is true beyond any doubt that American people had great expectations, nay a conviction, that with our so-called inventive genius

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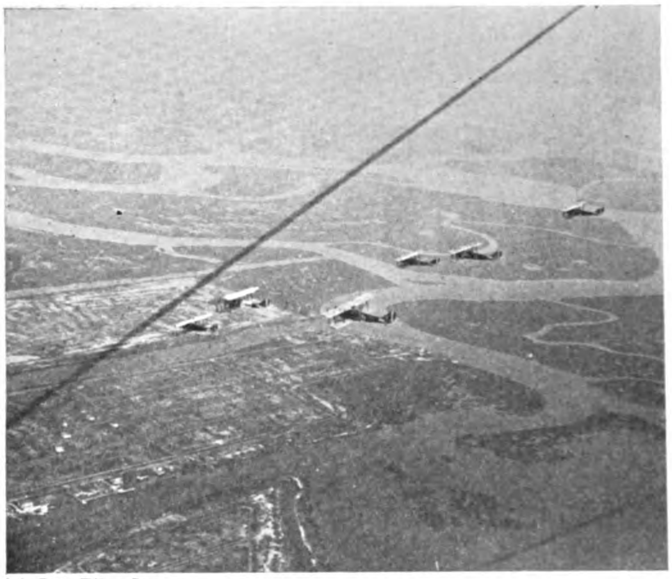
* Abstract of an Address at the University of Virginia.



(c) Int. Film Svce.

These airplanes remind us that the so-called Liberty engine, the result of scientific investigation, has no superior in the world. It weighs but 2 pounds per horse power

we would seriously influence the war, perhaps stop it, by the epoch-making inventions which our professional, highly advertised inventors would quickly make. The newspapers helped in fostering this belief, and many were the proud boasts which we heard. There was a great disappointment, almost a shock, as the days went by, the periods promised for great accomplishment passed, and certain names almost disappeared from the public press. We have in fact stopped asking what has happened to the "wizards."

The reason is that the problem of this war is not to perfect an old device, but to design a new one; the knowledge required is not that of the amateur or even of the trained engineer, but definitely that of the scientific investigator, the man who by his own laboratory investigations has added to our store of knowledge.

One illustration of this may suffice; one government board, with whose activity I am familiar, has had submitted to it in the course of the year 16,000 projects and devices, proposed by so-called inventors; of these only five had sufficient value to deserve encouragement.

I have nothing but admiration for these 15,995 men, whose disappointment must have been keen. Most of them were more than willing to give their inventions freely to the government. The point I wish to emphasize is that the ability and knowledge required in waging this war successfully are not those possessed by any body of men except those with a profound knowledge of science and of scientific method. The problems are too complicated. It is true that with the help of trained technical men we will get better engines, better explosives, better guns; and for these we should be truly grateful to our much-boasted American genius. But, consider a problem like this: to devise a light signal, which can be used by day or by night, and which will be absolutely invisible to the enemy.

Who can solve that? The answer is obvious: only a physicist.

In times of peace, when commercial development is uppermost in men's minds, the university scholar is at a great disadvantage. He rarely knows what problem is to be solved. He is busy with his own studies and researches, and does not come in contact, in the ordinary course of life, with the demands of the technical trades. His discoveries are made use of, and are always—sooner or later—of commercial value; but in this later stage he es not take part.

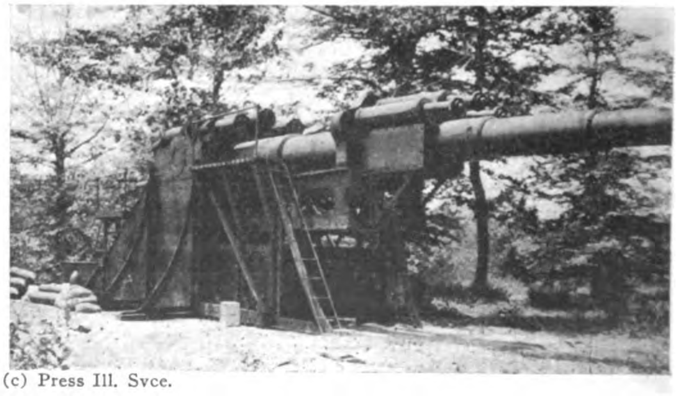
Nearly all of our great technical companies maintain extensive laboratories where trained men pursue investigations in pure science; but problems are rarely given them to solve. Today, in order to meet the insistent demands of the war, the whole process is changed. On every battlefront of Europe, attached to the various staffs, are men from university faculties, skilled in observing, quick to learn what is needed. In Paris, London and Rome there are groups of university men whose duty is to collect data from the Allied powers along similar lines. Reports containing clear statements of the problems are cabled to Washington. To this same center come requests for help from our own forces on this side of the ocean. Then, as soon as the problem can be formulated with definiteness, one or more men are asked to find the solution.

For the first time in the history of science, men who are devoting their lives to it have an immediate opportunity of proving their worth to their country. It is a wonderful moment; and the universities of this country are seizing it. The stimulus to scientific work is simply enormous; and the growth of our knowledge is astounding. In many cases investigations are prolonged for months, and in the end possibly the much desired solution is not obtained; but in any case new methods are made available for future use, new instruments are perfected, and the store of human knowledge is vastly increased.

Let me give one illustration of this reaction of the demands of war upon pure research. In the construction of a mask to be used in case of a gas-attack it is obvious that one method of defense is to make use of charcoal which is known to absorb many gases with great rapidity. A scientific problem was to try to increase the efficiency of this absorbing action; and it was soon discovered that by a special treatment of charcoal made in special sizes from special wood the absorptive power could be increased enormously.

Here is a fact of the greatest importance to the chemist, a fact which will be remembered in countless investigations of the future; and yet it is doubtful if it would have been discovered for many years to come if a particular chemist had not been asked by the military officers to help them.

My thesis is the importance of the work of the trained man of science in this war, with emphasis upon the fact that his great usefulness should not be a matter of surprise, as it is to most Americans. The best way of demonstrating this is to give a few illustrations, chosen from a wide field and not limited to the scientific work of any one country. Naturally I can refer only to those matters which have been revealed to the public; but I trust that many of them will be new. I have this confidence because so far the newspapers of this country have not believed that these questions would make what is called a "story."



(c) Press Ill. Svce.

This model of the monster 75 mm. gun illustrates how profound must be the knowledge of science which wages war successfully

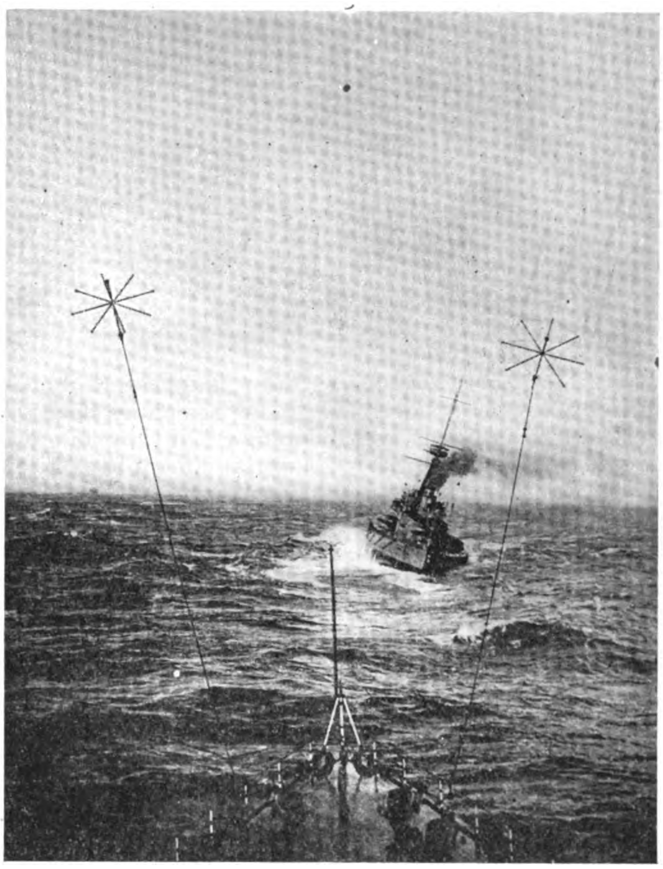
It is not easy to make a selection of the scientific problems, nor to arrange them in any logical order. There are two subjects uppermost in the minds of everyone: the airplane and the submarine. The scientific questions which have arisen in regard to each are most varied.

The airplane itself is an engineering structure; and we have confined ourselves in this country largely to the design and production of an engine. This does not really come under my general subject, but every one is so interested in it that I feel justified in referring briefly to what we have done. Our task was to produce on a great scale a powerful, efficient engine. This is now being done. The so-called Liberty 12-cylinder engine does not have its superior in the world, and further, it was so designed that it could be manufactured on an enormous scale, at least 1,500 a month. This engine has over 400 horsepower and weighs close to 800 pounds, and therefore it is useful for seaplanes, two-seater machines and bomb-droppers, but not for small machines.

When the same engine is made with 6 cylinders, developing about 220 horsepower, and weighing about 400 pounds, we will have an ideal engine, not equalled by any now in existence, for speed scout machines.

We could not have followed any plan more useful to ourselves and the Allies than to make this concentration of effort. Our eminent success is a cause of pride to every American.

With regard to the airplanes, considered apart from their engines, a few statements of fact must suffice, but they are facts. The best airplanes in service today, for each and every purpose, are those of British and French design. This is the result of real scientific investigation. The resistance offered by wings of different sections, the stability of the airplane, the character of the covering surfaces have all been investigated, and the finished product is the result of the knowledge thus acquired.



Central Photo News Svce.

This close up view of an armed cruiser's wireless aerials calls to mind the improvement in naval communication, which also may be credited to the work of trained physicists

We are doing similar scientific work in this country today, and, as we have engineers and manufacturers unsurpassed in the world, the time is not long distant when a truly American airplane will be made. We shall suffer, however, one serious detriment during the war; we are so far away that it will be extremely difficult for us to make the alterations in design which the varying conditions of modern war impose. Difficulties of transportation are great, and it is a serious question whether it would not be best for us to remove bodily our most important airplane shops directly to the Continent.

From a scientific standpoint the most important questions arising in connection with airplanes are instruments of navigation and methods of signaling to and from the ground and each other. Each machine should have for ordinary flights an instrument to indicate height above the ground, another to give the speed of flight through the air, another to tell how steep is the ascent or the descent, and many others. For long-distance flights a compass is necessary, and other instruments as well. The design of each of these is a distinct scientific problem.

Think of the requirements for a compass to be used with an airplane; for a ship on the ocean the problem is complicated, but how much more so for a vessel which turns rapidly, revolves in spirals, and which practically never keeps a constant course. In practice even more difficulties arise. The whole question of airplane instruments is still unsettled to a certain extent; many essential instruments have not as yet been designed, and improvements are needed in them all. Scientific men in all countries, including our own, have the matter under study; and the results so far accomplished are truly wonderful.

In the use of airplanes for observation purposes, or in squadron formation in making attacks, it is essential for the men in the machines to communicate with the ground. Many systems are in use, involving the application of light signals, wireless telegraph, etc. Obviously the proper instrument would be the wireless telephone, and that is surely coming, and soon it will be possible for one pilot to talk to another or with the commanding officer on the earth; and the latter can give orders to all of his machines in the air.

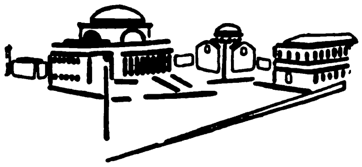
The objection to the use of all forms of wireless apparatus, telegraph or telephone, is that the enemy may confuse the signals by using the same wave-length for his disturbing impulses. This may be prevented however. Under the demands of the modern army, all forms of wireless have been so perfected that the progress made is a source of surprise and wonder. In fact there have been made in this country certain modifications and improvements which are held rigidly secret. It is interesting to note that every one of these alterations in wireless operation was first worked out in physical laboratories, by trained physicists.

Closely associated with the airplane is the balloon, either a dirigible or an observation one. The great problem here is to find a means of inflating it with some gas which is non-inflammable.

Hydrogen is now used in general; and, when a balloon is brought down in flames, it means that the hydrogen has caught on fire. This problem is partly physical and partly chemical; and numerous experiments are now in progress, all being directed by university men.

The tactics of fighting in the air are essentially unique, and before long we shall see a land-service, a sea-service and an air-service.

Progress In Radio Science



An Enclosed Rectifier

A RECTIFIER suitable for use with alternating currents over a current and voltage range comparable to the capacity of a mercury arc rectifier has been designed by G. S. Meikle.

It differs from devices employing incandescent cathodes exhausted to a lamp vacuum in that an inert gas such as argon at a considerable pressure is injected into the enclosed medium.

No very definite lower limit of pressure can be assigned; for practical operation it should be below one millimeter of mercury, for at very much lower pressures the cathode disintegrates rapidly.

The electrical characteristics of the tube shown in figure 1 are substantially those of an electric arc; and as a rectifier currents of many amperes—depending upon the size of the apparatus—can be rectified, without discharge of any current in the reverse direction. These results are obtained with a low voltage drop, which in argon is approximately 1 to 2 volts, and which varies with the temperature of the cathode, pressure of gas and other conditions.

Various inert gases may be introduced into this rectifier. Among these gases argon possesses several marked advantages. For example, an arc in argon exhibits a very low voltage drop. Under favorable conditions the difference in potential across the electrodes between which the arc is operating is only about 1 to 2 volts. Argon, being gaseous at ordinary temperatures, protects the incandescent cathode from disintegration at the very start of the operation of the rectifier, whereas mercury vapor, which exhibits the next most favorable voltage consumption to argon, is condensed to the liquid state when the arc is not operating, so that some disintegration of the electrodes takes place before the mercury has become vaporized. A bulb filled with argon is also more transportable than one containing mercury.

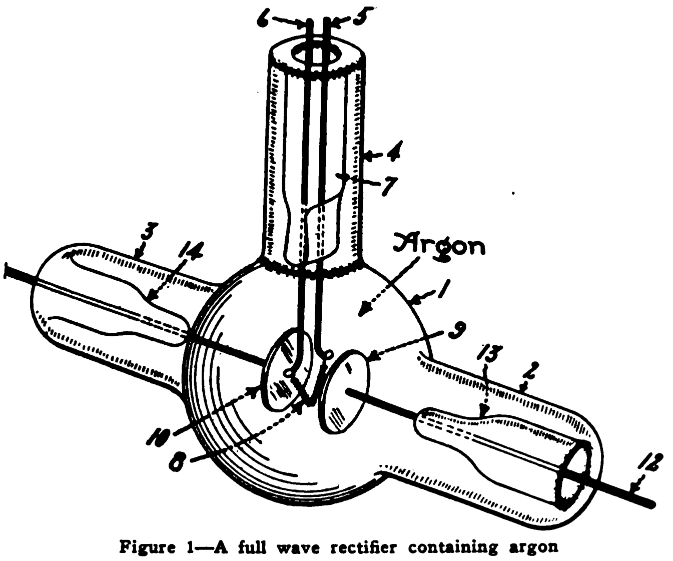


Figure 1—A full wave rectifier containing argon

Figure 1 illustrates a full wave rectifier containing argon; figure 2 illustrates one particular form of half wave rectifier, and figure 3 is a diagram of electrical connections.

The full wave rectifier shown in figure 1 comprises a glass envelop 1, which has three side arms 2, 3 and 4, provided for the convenience of sealing in the leading-in conductors. The cathode conductors 5, 6 may, for example, consist of tungsten sealed directly into a stem 7 of low-expansion glass, such, for example, as sodium-magnesium boro-silicate, although any convenient seal may be used. The cathode comprises a filament 8 of tungsten, or some other highly refractory material, operable at a temperature of about 2,000° C., at least. The cathode is heated to incandescence during operation, by a battery as indicated at 16, figure 3, or from any convenient source of current. In some cases, the heating current may be cut off after the discharge or arc is started, particularly when the gaseous atmosphere is at high pressure; enough energy will be liberated by the arc to maintain a portion of the cathode at a sufficiently high incandescence.

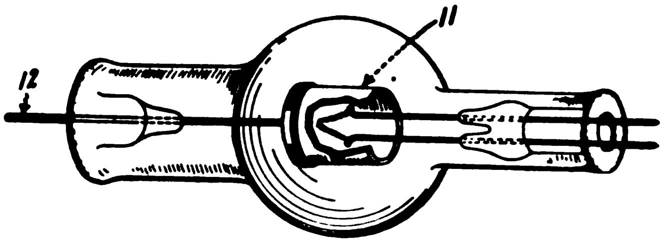


Figure 2—Illustrating one particular form of half wave rectifier

A clean, refractory metal, such as tungsten, at incandescence is a primary source of electrons. As indicated in the drawings, the cathode filament is conveniently coiled so as to minimize the heat losses and at the same time provide maximum surface within a given space.

The anodes 9, 10, are relatively much larger than the cathode and may have the form of disks, as shown in figure 1, or may consist of a cup, or cylinder in a half wave rectifier as shown at 11, figure 2. The anodes consist of tungsten, although any highly refractory material may be used. The tungsten anode terminals 12 may be sealed directly into stems 13, 14, of low expansion glass.

The envelop is first very carefully evacuated and baked out at as high a temperature as the glass will stand without softening, so as to remove residues of air and water vapor. Unless the anodes have been freed from gas previous to mounting—for example, by heating to a high incandescence in a vacuum—they should be freed from deleterious gases in the tube by electron bombardment, by impressing between the cathode while at incandescence and the anode to be purified a voltage high enough to cause an electron current to flow, but insufficient to produce appreciable positive ionization. Deleterious gases are thereby driven out of the anode. The evacuation may then be continued and the voltage progressively increased as gas is removed.

A quantity of argon is then introduced into the envelop. The gas is preferably at a pressure varying from about one centimeter of mercury pressure upward to atmospheric pressure. No definite lower limit of pressure can be assigned, but the pressure should be high enough to largely suppress electrical disintegration of the cathode by bombardment of ions.

When the gaseous pressure is low, it is necessary to provide for greater electron emission at the cathode than is necessary to convey the current; for example, by increasing the temperature of the cathode. A negative field is thereby established about the cathode; the bombardment of the cathode by positive ions and its disintegration, is reduced by the presence of these electrons, which apparently return to the cathode.

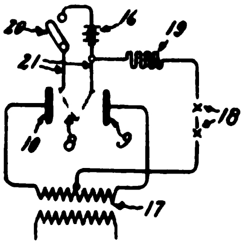


Figure 3—Diagram of electrical connections for enclosed rectifiers

At the higher pressures the electrical disintegration, or sputtering, of the cathode is correspondingly less and the useful life of the device is correspondingly longer, so that a high electron emission is not necessary to give a long life; although, of course, a high electron emission may also be employed even at higher gas pressures. The thermal disintegration is also less at higher gas pressures. As the pressure of the gas increases beyond a certain limit, varying with the nature of the gas—which, as in the case of argon, is somewhat less than one centimeter of mercury pressure—the voltage drop in the tube increases. In most cases, however, it is desirable to operate at a gas pressure substantially above the region of minimum voltage drop in order to secure a fair life. However, when currents of low voltage are to be rectified and the highest efficiency is desired, the voltage drop permissible may make it desirable to sacrifice life to efficiency to some extent, and therefore, to operate at the pressure of minimum voltage drop. Ordinarily this is not desirable.

As shown in figure 3, the anodes 9, 10, may be connected to the terminals of a source of alternating current, such as the secondary of a transformer 17, the cathode 8 being connected to an intermediate point of potential in series with a load 18, and a series resistance 19. The device is started after suitable connections have been made by closing the switch 20 in the heating circuit 21 and heating the cathode to incandescence.

The electrical operating characteristics of the device are those of an arc; that is, an increase of current produces little appreciable instantaneous change of voltage. However, inasmuch as an increase of current will also increase the gas pressure, an increase of current is accompanied by an increase of voltage drop if sufficient time has elapsed for adjustment of pressure.

Wireless Time-Signaling Device

EDOUARD BELIN, of Paris, has developed an apparatus for synchronizing time clocks from one main radio station, permitting at predetermined intervals a correction of errors encountered in the clock mechanisms. Several methods are available for obtaining coincident effects at the transmitter and receiver, one described by M. Belin, follows:

Figure 1 shows a diagrammatic representation of the apparatus and electrical connections, while figure 1a is a view similar to figure 1 of the apparatus located at the receiving station. Figure 2 shows a sectional view of the auxiliary adjusting apparatus.

At the regulating station A a clock or chronometer 1 periodically closes a contact in the circuit of the battery 2. This circuit passes into the relay 20, causing the wires 3 to radiate electric waves and form the regulating signal; at the same time current passes through the electro-magnet 4, attracting the armature 5, which on being displaced releases a stop 6 on the main drum 7, which in turn is driven by a motor through the friction clutch 8 and runs at a speed rather greater than that corresponding to the period of the chronometer 1. Therefore, between two consecutive closings of the circuit by the chronometer, the drum 7 makes one turn.

At the receiving station, shown in figure 1a, a chronometer or clock 1′ is provided which is identical and isochronous with the chronometer 1 of station A. Its operation is also similar to that of the station A in that it releases at similar intervals by means of the electro-magnet 4′, its armature 5′ and stop 6′, and a drum 7′ driven by a motor through the friction clutch 8′. This is not the driving drum. The drum 7′ must control, and bring into synchronism with it, a drum 7″ driven through the friction clutch 8″ by means of a system comprising the electro-magnet 4″, the armature 5″ and the stop 6″, but the moment at which it can release the stop 6″ can be regulated to coincide with the moment when 4′ is operated.

For this purpose the drum 7′ is provided with a contact 9, which at each revolution strikes against a contact 10, closing the circuit of the battery 2″ through the electro-magnet 4″. In parallel with this circuit is arranged the receiver E, in such manner that the closing of the contact can be detected. By listening, it is then possible to hear both the signal emitted by the main battery 2 and the signal by the controlling battery 2′. This in practice will hardly ever be in coincidence. All that is necessary then is to move the contact 10 by displacing it, manually through the screw 11 and the wheel 12 around the axis of rotation of the drum 7′ in such manner as to obtain an exact coincidence. At this moment the synchronism of the drum 7′ will be identical with the drum 7 which were formerly only in isochronism. The synchronism will therefore remain as long as isochronism exists between the two chronometers or the clocks 1 and 1′.

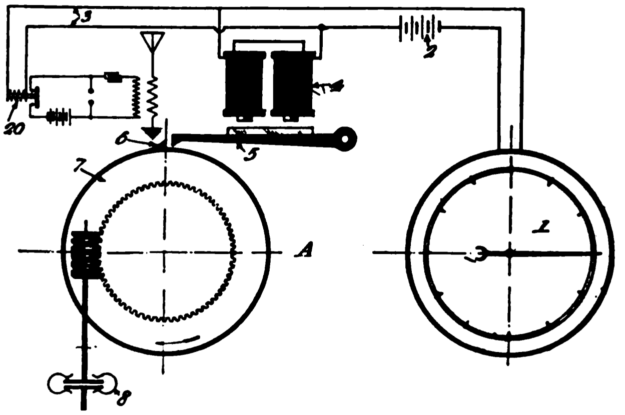


Figure 1—Diagram and electrical connections of wireless time-signaling device at the regulating station

In figure 2 is a sectional view showing the method of operation of the parts 7′, 8′, 9, 10, 11 and 12. A support 13 carries the shaft 14 of the drum 7′ driven by means of the screw or pinion 15 through the direction clutch 8′. This shaft 14 is provided at its other end with a disk 16, in which is embedded the contact 9 in the form of a ball spring pressed outwardly. The shaft 14 serves as an axis and as a support to the hollow shaft 17 of the wheel 12, which carries the contact 10. The wheel 12 may be displaced by the screw 11 and consequently regulate the instant at which contact is made between 9 and 10. The electric circuit is connected to the shaft 14 and to the wheel 12. It will never be necessary to regulate the coincidence of the signals detected in the receiver E for a duration greater than that of a half period of the clock, because the wheel 12 can turn in either one direction or the other, and consequently this regulation can be made very accurately in a very short time.

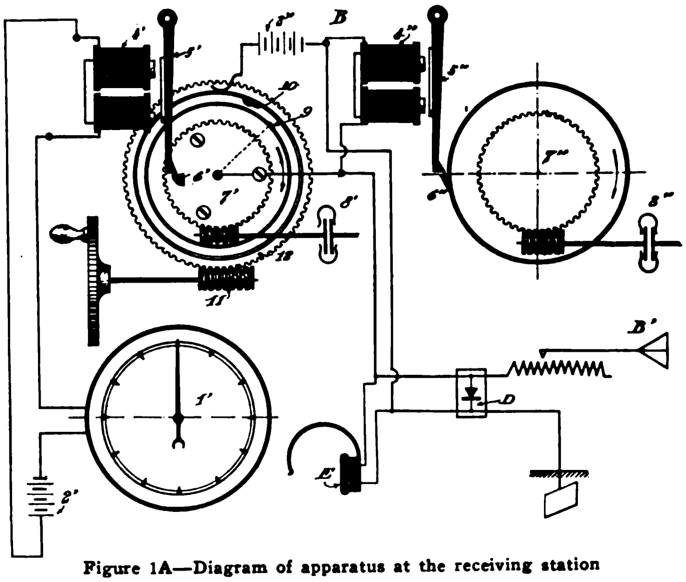


Figure 1A—Diagram of apparatus at the receiving station

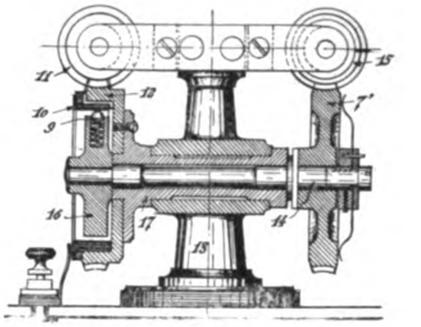


Figure 2—Sectional view of the auxiliary adjusting apparatus

The drums 7 and 7″ can be employed for very different purposes and may be connected either by wire or without, which in itself is independent of the solution of the synchronizing problem; for example, the exact time may be received by means of a series of suitable rotations occurring once every second. The signals transmitted by the one may be received by the other with great accuracy. Also synchronism may be obtained, for example, for the transmission of messages, photographs or pictures by wireless or line telegraphy, the synchronism in these latter cases being regularly regulated in a simple manner during the transmission of the other emissions.

Incandescent-Cathode Arc Device for the Rectification of Alternating Currents

IN the accompanying drawings, figure 1 illustrates diagrammatically a discharge tube which may be used as a rectifier; figure 2 a modification in which the standing filament is omitted and the arc is started by means of a high-voltage discharge from a pointed cathode. Another modification having a mercury anode is shown in figure 3. These rectifying devices have been developed by Chas. V. Ferguson.

Referring to figure 1, the discharge device consists of a sealed glass or quartz envelop 1, and the cathode 2 and anode 9, both of these electrodes being sealed into the container in the usual manner and consisting of highly refractory substances, such, for example, as tungsten, tantalum or carbon. The cathode 2 consists of several parts, namely, an arcing tip 3, connected to a stem 4 having a diameter small enough to afford enough resistance to the conduction of heat to enable the arcing tip 3 to operate at incandescence. The stem 4 is connected to a current-conveying conductor 5 sealed into a stem 6. The arcing tip should be so arranged and supported that the heat lost by conduction through the supporting stem consists of such a small fraction of the total heat, developed by the cathode that the arcing tip is maintained at a uniformly high temperature by a comparatively small amount of energy. Consequently, with a given current the total voltage across the arc is lower than it would be if no section of reduced diameter was provided. This result can be conveniently obtained by reducing the diameter of a small section 7 of the supporting stem adjoining the arcing tip as shown in figures 2 and 3. In some cases the cathode has a pointed or sharpened tip (as shown in figures 2 and 3) to facilitate starting and secure greater stability of the arc.

Near the arcing tip of the cathode is the starting filament 8, consisting of refractory material such as tungsten, tantalum or carbon spirally spaced about the cathode stem and connected to the cathode stem 4 at one end near the tip 3 as indicated, the end remote from the arcing tip of the cathode being attached to a

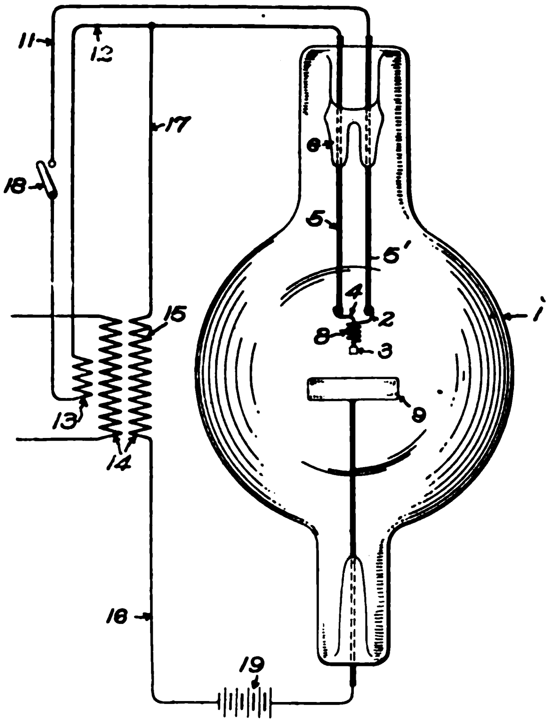


Figure 1—Diagram of a discharge tube used as a rectifier of alternating currents

(Continued on page 43)

Military Lines of Communication*

A Series on Reconstruction for American Soldiers Abroad in U. S. Army Service

By Major J. Andrew White

Chief Signal Officer, American Guard

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Nineteenth Article—Aerial Line Construction

SHORT and stout poles are favored by the Signal Corps for telegraph-line construction, as these are more durable than the high poles of former days and better able to stand load strains and attacks of storms.

To avoid using a large number of aerial wires, cables are utilized whenever practicable in aerial construction, lightning arresters being always installed and telephones connected to an aerial circuit. Outside distributing wire is provided for leading from the pole to substations.

ERECTION OF THE LINE

The route of the line having been decided and materials prepared, the distance is measured and stakes driven to indicate the places where the poles are to be erected. When the line is to follow highways or other defined routes, the stakes are placed so as to avoid, as far as possible, danger to the line from passing vehicles. The line is generally removed from the road a distance of about 30 feet, which insures that traffic will not be interrupted or endangered should a line become detached from insulators and hang down. The line is so placed that it can be readily examined and inspected from the road. Roads are crossed only when necessary to avoid bad ground or numerous trees, or when a material shortening of the line may be thus gained. Crossings are made at half a right angle, the distance between poles being shortened and a minimum height of 18 feet observed between wire and the crown of the road.

When the road is through rolling country, poles are planted near the crest of hills, so the wire between will be at sufficient height above the ground. Longer poles are used in hollows so the line will be graded.

In open, or unfenced country the poles are, as a general rule, set in a straight line, but wherever there is a well traveled road the line follows its general direction.

WOODEN POLES

Red cedar, black locust, or chestnut are preferred woods for poles. Where these are not procurable, or the cost is too great, redwood, white cedar, red cypress, yellow cypress, tamarack, fir, larch, spruce, white or post oak and sassafras furnish timber from which good service may be expected.

Live green timber, free from rot and sound in every respect, is sought for poles. November to the end of February is the cutting time, each pole being trimmed closely and smoothly and containing the natural butt of the tree and presenting an approximate uniformly decreasing cross section from butt to top.

The table following gives the desired dimensions of wooden poles:

Length of Poles—Ft.	Circumference—Ins.		Length of Poles—Ft.	Circumference—Ins.	
	At Top	6 ft. from bottom		At Top	6 ft. from bottom
20	14	24	35	22	37
20	16	25	35	25	40
25	16	25	40	22	40
25	19	27	40	25	43
25	22	30	45	22	45
30	19	30	45	25	46
30	22	34	50	22	46
30	24	36	50	25	48

For permanent lines under ordinary conditions preservatives will be found worth the additional cost, for they not only delay the starting of decay but retard it when once it has started.

Computing the increase of life of poles by the use of preservatives requires consideration of the factors represented by the kind of wood, nature of soil, the amount of preservative and depth of impregnation; owing to these varying factors it is believed impracticable to definitely state the life increase thus obtained. Most important among these factors is the depth of impregnation and the amount of preservative per cubic foot of wood. A heavy coat on the outside is not so efficient as the same amount forced into the pores of the wood.

A line for temporary use, shown for contrast with the semi-permanent lines described

Three methods of applying preservatives are in use: (a) brush, (b) open tank, (c) pressure process. The brush method applies the preservative by a brush to the part of the pole to be treated, after it has been thoroughly cleaned. The second method immerses the pole or its butt into a tank of preservative, the solution being kept hot until the bubbling caused by air or water in the pole ceases. The hot preservative is then allowed to cool, assistance in drawing the preservative into the wood being given by the vacuum created in the timber while heating. The pressure process obtains great penetration but is seldom used on account of its cost. The brush method secures a penetration of 1/16 inch to less than ¼ inch, whereas the open tank treatment ranges from ¼ inch to ½ inch.

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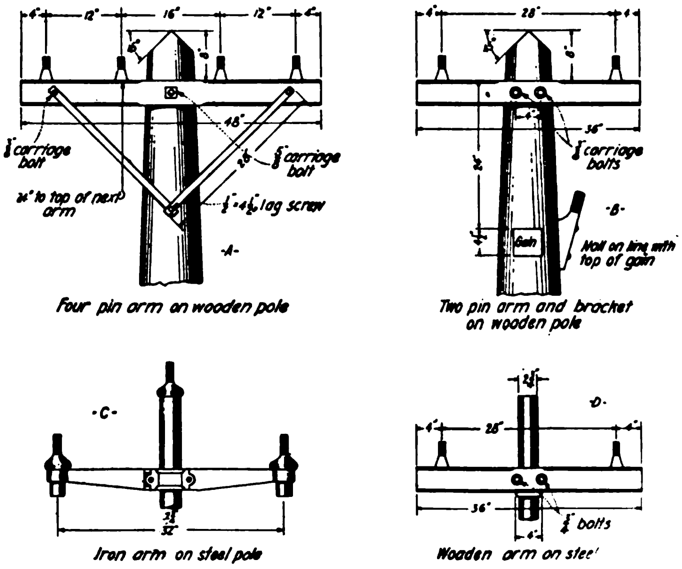
* For complete text on this subject see the book, "Military Signal Corps Manual," by the same author.

The part of any set pole most susceptible to decay is a section from a few inches above the ground-line to 2 or 3 feet below the ground-line.

Pine poles have a short life both above and below ground, and if this timber is used for a line in any way permanent, the entire length should be treated.



Four pin arm on wooden pole

Two pin arm and bracket on wooden pole

Iron arm on steel pole

Wooden arm on steel

Figure 1—Method of preparing wooden and steel poles for cross arms

Concrete Poles

Difficulty of transportation and delivery along the route makes the use of concrete poles inadvisable for telegraph lines. For post telephone systems, however, reinforced concrete presents several advantages.

The forms are prepared by securing 3 pieces of 2-inch plank, free from knots, and dressed on one side. Top and side cleats prevent spreading when the concrete is poured through the open side, or top.

For longitudinal reinforcements, four ⅜-inch square or twisted steel bars are used for 24-foot poles, and ½-inch bars for longer poles. The four bars are set about ½ inch from each corner, being spaced by a piece of wood at each end of the form, with holes to take the ends of the rods. At four or five points the four rods are bound together by iron wire. Wooden blocks or wire hold the reinforcing rods in position at various points to prevent sagging. These are removed as the concrete is poured.

The concrete used should be a very wet mixture, 1 part cement, 2 parts sharp sand, 4 parts crushed stone of less than ½-inch size. It is important to have sharp sand. Gravel may be used in place of crushed stone, but it should be cleaned well.

The two side walls may be removed the next day after pouring, the bottom plank remaining three days longer, at which time the concrete is sufficiently set to remove it, heavy ice tongs being employed to slide it endwise. Before the concrete is entirely set the surfaces should be finished by a small amount of troweling. Concrete poles should be allowed to cure about 30 days before use.

When bolt holes and pole steps are desired, wooden pins should be placed in the form before the concrete is poured.

Concrete poles having a length of 24 feet should be about 8 x 8 inches at the base and 5 x 5 inches at the top. Beveled corners improve the appearance. The weight of a 24-foot pole is approximately 1,100 pounds, and 30-foot poles, 1,400 pounds. A 24-foot pole having an 8-inch square base and 5-inch square top requires about 7 cubic feet of concrete. Twenty-four-foot poles should be set approximately 4 feet in the ground, and 30-foot poles approximately 5 feet in the ground.

Depth of Setting Poles

Character of the soil, height of the pole and load it is to carry, determine the depth to which poles should be set. Less depth is required in rock, gravel or stiff clay than in light loam or sand. The following table gives the depths for average conditions:

Length of Pole Feet	Depth in Ground Feet	Depth in Solid Rock Feet
18	3[1] 3½[2]	3
20	4	3
22	4	3
25	5	3
30	5½	3½
35	6	4
40	6	4
45	6½	4½
50	7	4½

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[1] On straight lines. [2] On corners.

A foreman follows with a sufficient number of men equipped with digging bars, spoon shovels, the ordinary long-handled shovels, or post-hole diggers, where the soil will admit of their use. This party digs the holes for the poles as marked out by the stakes. If there is a sod, one of the men, equipped with an ordinary spade, is sent ahead to remove it, indicating the size of the hole to be dug and facilitating the work by performing the part for which the bars and spoons are not well adapted. The foreman sees personally that the holes are put down to the proper depth, has direction of the detail and is held responsible for good service.

Setting the Poles

Holes should be dug large enough to admit the pole without the necessity of cutting away the butt, and space should be allowed to move the pole about for bringing it into line. The diameter of the hole should be great enough so the tamping bar may be used full depth. Thorough tamping as the hole is filled is important to the proper setting of the pole.

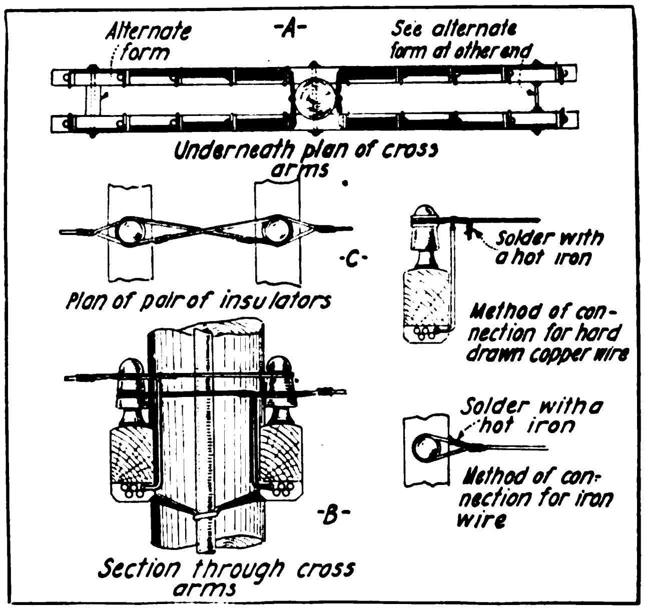

Alternate form
-A-
See alternate form at other end
Underneath plan of cross arms
-C-
Plan of pair of insulators
Solder with a hot iron
Method of connection for hard drawn copper wire
Solder with a hot iron
Method of connection for iron wire
-B-
Section through cross arms

Figure 2—Double arming for aerial line construction

On straight lines, the cross arm should be placed at right angles to the direction of the pole line, the arms on adjacent poles facing in opposite directions. At line terminals the cross arms on the last two or three poles should be placed on the sides of the poles which face the terminal. The poles are set vertically.

On curves, the cross arm should be placed on the sides of the poles which face the middle of the curve. Corner poles should be given a slight rake when set, varying from 10 to 20 inches with the conditions.

After the pole has been placed in position, the hole filled, and the earth well tamped, the soil should be well banked up about the pole and firmly packed in place; otherwise, subsequent settling of the earth will form a depression about the base of the pole. Coarse material, soil or gravel, should be used at the top of the holes. Where the poles are set in rock, the pieces should be firmly wedged in about the poles.

Wooden poles usually have more or less pronounced curves; these curves should be placed in setting so as to be least apparent when viewed from the direction of the line.

In obtaining uniform height of lead by grading the poles, differences in height of poles up to 2 feet may be taken care of by digging the holes deeper. Poles should be cut only as a last resort, and then at the top, not at the butt.

Number of Poles Per Mile

The character of the country and the number of wires or cables to be supported determines the number of poles to be provided for a line. The minimum provision is 35 poles per mile, but in timbered country, with crooked roads and heavy leads, it may be necessary to increase this number to 45 poles, or even more in special cases.

Delivery of Poles

As soon as practicable after the holes have been dug the poles should be delivered. Carrying hooks to move them as they are unloaded from trucks is the only special equipment required.

The heaviest and longest poles should be selected for crossings and long spans, the stoutest poles where angles and sharp curves occur. The butts of the poles are laid at the edge of the holes, with the tops pointing along the ground in the direction from which the raising party will come.

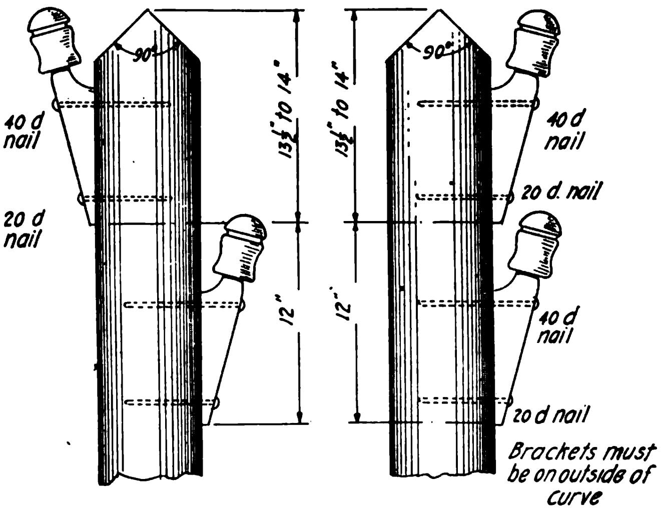


Figure 3—Method of roofing wooden poles and attaching brackets

Pole Preparation

So that the poles will effectively shed rain and snow, the tops are roofed by cutting each side to a peak at an angle of 45 degrees, as shown in figure 1.

Cutting poles when the sap is down, removing the bark and allowing them to season, increases durability and facilitates transportation and erection.

Lightning Rods

Sometimes, every fifth to tenth pole of an aerial line is provided with a lightning rod. The rods ordinarily consist of a piece of number 6 galvanized iron wire, extending not less than 1 foot above the roof of the pole and attached to its sides by means of staples placed about 1 foot apart. Lightning rods should extend continuously down the entire length of the pole, and are usually soldered to a ground rod driven into the earth near the base of the pole. An alternative method provides for their ending in a small coil of wire at the base of the pole which gives a good surface contact with the earth. This wire should be kept as straight as possible without turns or coils in its length and should be attached before the pole is erected.

In this illustration may be seen the roofing of the top, method of placing brackets and erection of the pole so as to avoid danger to the line from passing vehicles on the highway

Cross Arms

The Signal Corps specifies the following dimensions for standard cross arms which it supplies:

Length in Feet	Number of Pins	Pin Spacing—Inches		
		Ends	Sides	Centers
3	2	4	..	28
4	4	4	12	16
6	6	4	12	16
8	8	4	12	16
10	10	4	12	16

Framing Poles

The following directions cover the method of framing poles which support cross arms:

The pole should be raised at the top and placed in a framing buck or horse so that the heaviest sag or curve will be nearest the ground. If the pole is crooked or badly shaped, it should be turned with a cant hook until the best side for framing is uppermost. With the pole then held rigidly in place it is roofed, after which the gains should be cut, leveling them with a straightedge or sighting stick.

Before holes are bored for the cross arm bolts, a line should be set off from the center of the pole's top to its butt, and the bolt hole center laid off along this line.

Half-inch holes for steps should be bored at right angles to the line, or in line with the cross arms, beginning 18 inches from the lowest cross arm and continuing to a point 8 feet from the ground, spaced 18 inches apart, or 36 inches apart when measured on the same side of the pole.

Cross arms carrying four or more wires must be braced. Figure 1 shows the method. Gains for cross arms have a maximum depth of 1¼ inches.

A distance of 8 inches is allowed between the extreme top of the pole and the upper side of the top gain. The distance to be observed between centers of gains is 2 feet. Cross arm braces should be attached to the face of the pole and to the face of the arm. Cross arms which are not braced require two lag bolts. Except where special conditions require otherwise, cross arms must be placed on opposite sides of alternate poles.

Cross arms should be set at right angles to the pole length. This applies as well to corner poles, no matter what the degree of rake.

Cross arm fixtures should, if practicable, be attached to buildings (other than residences) with bolts passing through the wall. If this is not practicable, large expansion bolts should be used. Window casements or woodwork of buildings should never be used for resisting the strain of the line.

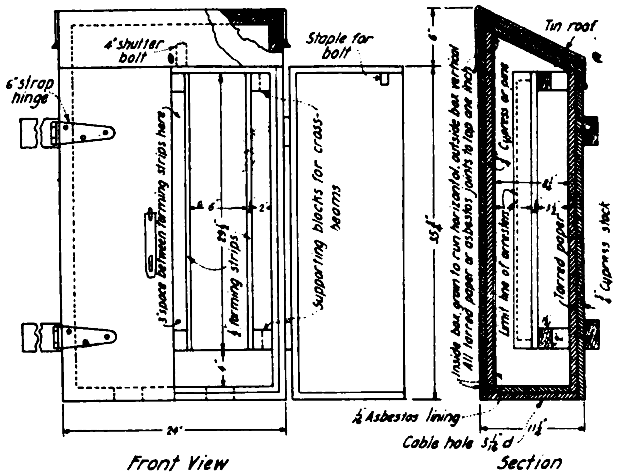


Figure 4—Construction details of cable box for terminal or office pole

Telephone line wires terminating at residences are provided with either outside distributing or outside twisted pair wire connections, the line wire being terminated at the cross arm or bracket at the nearest pole and the service completed by means of the outside distributing or outside twisted pair wire. A bracket or other type of fixture makes the wire fast to the residence, entrance being made through two porcelain tubes, each conductor of the duplex wire entering through one of these tubes. The tubes should be slanted downward toward the outside of the building so water will not enter them in stormy weather. If this is not practicable the same result will be secured by having the wires outside sag below the tubes. Wires thus arranged are termed "drip loops."

Wherever practicable, arms are placed on poles before they are erected.

Methods for attaching cross arms for leads not exceeding four wires are shown in figure 1: (a) illustrates the attachment of the four-pin cross arm with braces; (b) the two-pin cross arm attached with lag bolts; (c) and (d) show two methods of attachment to steel poles. These steel poles are only used occasionally to meet special conditions; they are not suitable for supporting more than four wires and should be installed only in hard earth or concrete.

Double Arms—The approved method of installing double cross arms is shown in figure 2. The heaviest poles available should be selected for double arm construction as these require extra strength for the additional load. Figure 2 also shows the method of dead ending wires on double cross arms. Where wires pass through they are tied to both insulators, in the lower groove of the glass if double-grooved glasses are in place.

Porcelain-coated bridle rings may be used for supporting bridle wire, instead of cleats as shown in figure 2, and copper connectors may be used for splicing bridle wire to hard-drawn copper line wire, instead of as shown in the same figure.

BRACKET LINES

Where not more than two wires are required on a pole line, oak brackets may be used in place of cross arms. General arrangements are shown in figure 3, brackets being attached to the pole with one 40d nail above and one 20d nail below. So that the poles on which brackets are placed may later be used to support cross arms, the top end of the brackets should be about level with the correct location of the top of the gain, so that the bracket and its wire will not interfere with the subsequent use of the cross arm.

TERMINAL OR OFFICE POLE

The terminal or office pole of a line carrying a number of wires is the most important part of the line and demands careful attention to secure construction that will be serviceable and easy to maintain. Frequent access to this pole being necessary, all wiring should be substantial in character and arranged to facilitate repairs and extensions. Typical construction of an office or terminal pole is shown in figure 5. This illustration shows the method which is to be followed as far as practicable, although it is not likely that in any construction work taken up it can be exactly duplicated.

This figure shows a can terminal installed; a cable box, shown in figure 4, may be used in its place and, in fact, is considered preferable except in the tropics. In ordering cable boxes the number of pairs to be accommodated should be stated, as well as the number of pairs of lightning arresters and fuses. No aerial line should be cross-connected at a terminal pole or to a central exchange except through fuses and lightning arresters. The terminal or cable-box poles should be stepped, using galvanized iron pole steps as shown in figure 5. The lowest of these steps should be at least 8 feet from the ground. To reach these steps ladders are used, or brackets, as shown in figure 6.

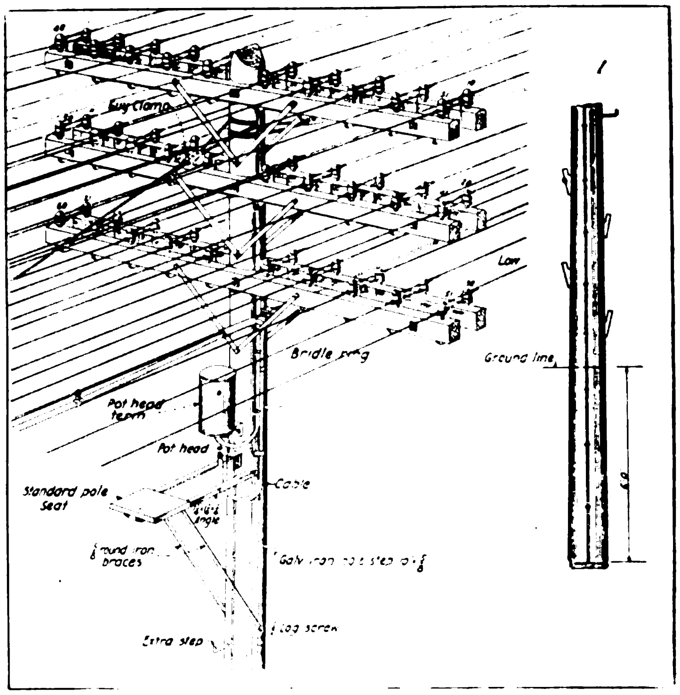


Figure 5—A typical terminal pole; Figure 6—Pole steps

Bridle wires, which are used to connect the line wires with the can terminal or cable box, run through hardwood cleats, are shown in figure 2. Particular attention should be given to all wiring about the pole to see that it fits neatly and is so placed that it will not be injured by the workman in the performance of his duties.

Where the wires which dead end on a double arm lead from one direction only, it is necessary to counterbalance the strain by running a small guy from this cross arm to the next pole.

Where poles are provided with steps, linemen should not use climbers, unless of course, such use is clearly unavoidable.

Static and Interference Eliminated

The Achievement of Roy A. Weagant

ROY A. WEAGANT, chief engineer of the Marconi Wireless Telegraph Company of America, has perfected an invention which has taken the "static" out of wireless telegraphy, thereby removing the greatest obstacle to the clear transmission of radio messages.

The invention prevents "by a selective system" the interference or crossing of one wireless message with another, regardless of the operation of any number of high-power stations, and it reduces the amount of power heretofore required to operate a wireless station by about one-half, making possible a saving of 50 per cent. in fuel. The following official announcement of the invention is made for the company by Edward J. Nally, vice-president and general manager of the Marconi Company:

With the conditions that pledged us to absolute secrecy no longer prevailing, the Marconi Wireless Telegraph Company of America is permitted to announce a discovery and invention in wireless telegraphy that will mark a new era in world communication. It is America's contribution to science in solving a problem that has engaged the best scientific minds of the world.

Ever since the genius of Marconi made wireless telegraphy a fact, the only limitation of this method of communication was the deadly phenomena of "static conditions." It was "static"—the presence of a large amount of uncontrolled electricity in the air—that at the beginning of the war often entirely prostrated the wireless service even between the most powerful stations erected in Europe and America. Static conditions were responsible for abnormal delays and for the mutilation of words in wireless messages.

It was the one great obstacle to continuous communication by means of electro-magnetic waves in the air. So baffling was the problem that Marconi issued a personal appeal to every wireless operator in the world to record his observations and to collect data on the subject. Some of the leading scientific minds in the universe struggled to overcome the effects of the static disturbances. Worldwide researches were instituted and large sums of money expended, but the end sought was not obtained.

It remained for an American radio expert, Roy A. Weagant, chief engineer of the Marconi Wireless Telegraph Company of America, to discover the solution of the static problem. Weagant practically had devoted his life to a study of this perplexing phenomena, and the result of fifteen years of experimental work was about to be published to the world, when the United States entered the Great War.

Although patent applications had been made and the claims allowed by the United States Patent Office, the Weagant system was immediately placed at the disposal of the American Government, and every precaution was taken to keep the invention secret until the discovery could be safely announced. With the spirit of research that has made the Navy such a magnificent arm of our military service, officials of the Navy Department assigned naval experts to co-operate with the inventor in installing experimental stations in various parts of the country. These stations are now receiving messages from all the high power wireless stations of the world.

With the consent of the Marconi Company, the United States Navy Department disclosed the Weagant invention to our Allies, and special representatives of the French and British Governments were sent here to study the system.

Among the revolutionary changes that the new system effects in wireless installations will be the immediate disappearance of the huge steel towers heretofore built at great height to catch the incoming wireless waves. Equipped with the Weagant invention, the wireless receiving antennae are stretched merely a few feet above the ground.

Heretofore, also, the increasing number of high power stations that were being erected in every part of the world raised the difficult question of "interference." Crossing wireless messages that shot through the ether sometimes made the wireless signals so indistinct that they could not be understood, or drowned the weaker transmission entirely. The Weagant system, based on a unique selective principle, eliminates "interference" and permits absolutely clear communication, regardless of the operation of other stations even in the immediate vicinity.

The notable contribution to wireless telegraphy opened by Mr. Weagant's discovery makes continuous wireless communication over the oceans and between continents an absolutely assured fact for twenty-four hours of the day and at every season of the year, regardless of atmospheric conditions. All the Marconi high power stations are being equipped with the Weagant system, and the stations of the Pan-American Wireless Telegraph and Telephone Company, which are to link North and South America in a closer bond of brotherhood, will likewise be so equipped. In all probability the United States, as well as the Allied Governments, will adopt this system.

Mr. Weagant, who has been a distinguished radio engineer for fifteen years, is only 37 years old. He is a graduate of McGill University in Canada and a Fellow of the Institute of Radio Engineers.

Mr. Weagant was born March 29, 1881, at Morrisburg, Ont. His father, William Weagant, the inventor of various mechanical devices, died when he was a baby, and his mother shortly after married T. J. Flint, a druggist, of Derby Line, Vt. The boy spent most of his school days behind the drug store counter. He attended the village school and later the preparatory school and college at Stanstead, Que. His interest in mechanics began when he was five years old, and he was encouraged by Dr. M. L. Baxter, a retired physician of Washington, who taught him about electricity and loaned him scientific books.

Radio Frequency Changers

Reported Progress in Their Application to Wireless Telegraphic and Telephonic Communication

By E. E. Bucher

Director of Instruction, Marconi Institute

(*Continued from the November,* 1918, *issue of* THE WIRELESS AGE)

Control of Antenna Currents

A PROBLEM of considerable magnitude is encountered in controlling the energy output of a high-power radio station so that rapid signalling can be effected. It is a relatively simple matter to interrupt the primary circuits of a low-power spark transmitter, but when several hundred kw. of energy is involved, very special means must be provided to permit the breaking of the current without undue arcing or lag.

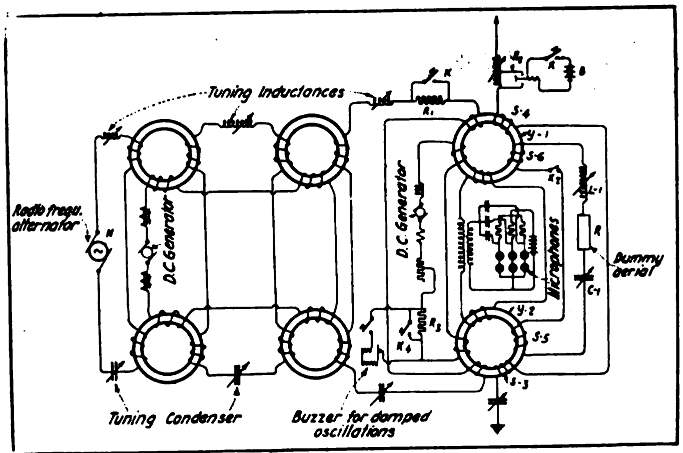


Figure 9—Frequency changer system for the production of damped or undamped oscillations with the complete circuits for wireless telephony

Marconi gave a satisfactory solution for high-power rotary spark transmitters when he devised his battery of special electro-magnetic keys to interrupt the high voltage current at points between the secondary of the transformer and the high-voltage condenser.

It has been customary in the arc radio system to effect signalling by changing the length of the radiated wave, but a disadvantage arises in this method that the antenna radiates two waves, one of which may cause interference to the operation of other stations.

Von Arco and Meissner have devised several interesting methods for controlling the antenna current for radiotelegraphy and telephony, which, in general, do not involve duplex radiation. They have shown as in the figure 9 the complete circuits of a radio system serviceable for telegraphic signalling by means of undamped oscillations, for the production of speech variations of the antenna current for telephony, and for the production of groups of damped oscillations, all from the same source of energy—a high frequency alternator.

In regard to the circuits for telegraphic signalling shown in this figure, a telegraph key operates a solenoid relay R_1 fitted with contacts which tune and detune the antenna circuit. The advantage of the frequency changer systems over the arc method is that, when the antenna is thrown out of resonance, no radiation takes place, for then no energy is withdrawn from the alternator N. However, the inventors observed that in controlling the antenna current in this way, the resulting shift of phase between voltage and current caused a dangerous rise of potential in the high frequency generator. To prevent this they placed a resistance R_1 in series with the primary circuit of the last group of the radio frequency changers, shunted by the key K′ which operates in conjunction with key K so that the signal is produced by tuning the antenna and short-circuiting the resistance R_1 simultaneously.

Controlling the antenna current in this way brought forth another problem, viz: the unloading of the generator N each time the antenna is detuned by the key K, causing the speed to vary, throwing it out of resonance with the complete system, with a consequent decrease of output. The well-known method of loading the generator by a special non-radiating circuit is then suggested so that when the antenna is not radiating the shunt resonant circuit takes the load, keeping the speed of the generator nearly constant. Practical circuits will be shown in the diagrams to follow.

In previous systems based upon this principle, it is necessary to interrupt the antenna circuit and the auxiliary loading circuit each time a telegraphic signal is made and in case large amounts of energy are involved, it is difficult to devise a signalling key that will operate satisfactorily. However, Arco and Meissner have shown a system of connections by which the antenna remains permanently connected to the source of high frequency current and the transference of the load from the antenna circuit to the auxiliary loading circuit and *vice versa* is obtained simply by variation of the tuning of the two circuits. The circuit is shown in figure 10 where two magentic relays R-1 and R-2 are connected so that their contacts shunt the antenna loading inductance L-1 and the auxiliary load inductance L-2 alternately, signalling being effected by closing key K. The secondary windings S-1 and S-2 of the last group of frequency changers are connected with the antenna and also with the loading circuit

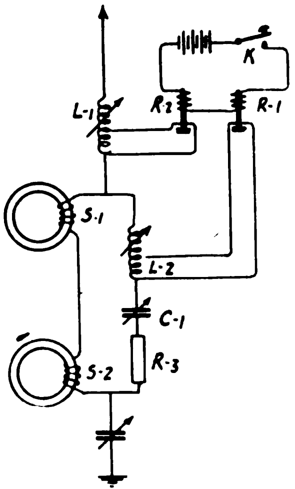


Figure 10—Signaling circuits for maintaining a constant load on the radio frequency alternator

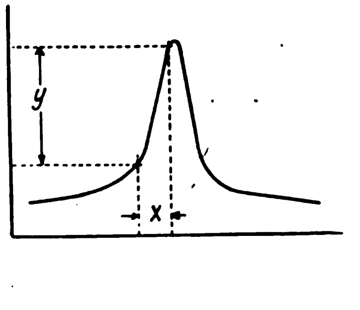


Figure 11—Curve showing antenna current for various values of impedance of the control system

containing the ballast resistance R-3, the condenser C-1 and the inductance L-2. It is readily seen that the connections with the relay R-1 can be so arranged that when the antenna circuit is tuned to resonance with the frequency changers, the relay R-2 detunes the load circuit and when the antenna circuit is detuned, the load circuit is tuned to frequency of the alternator.

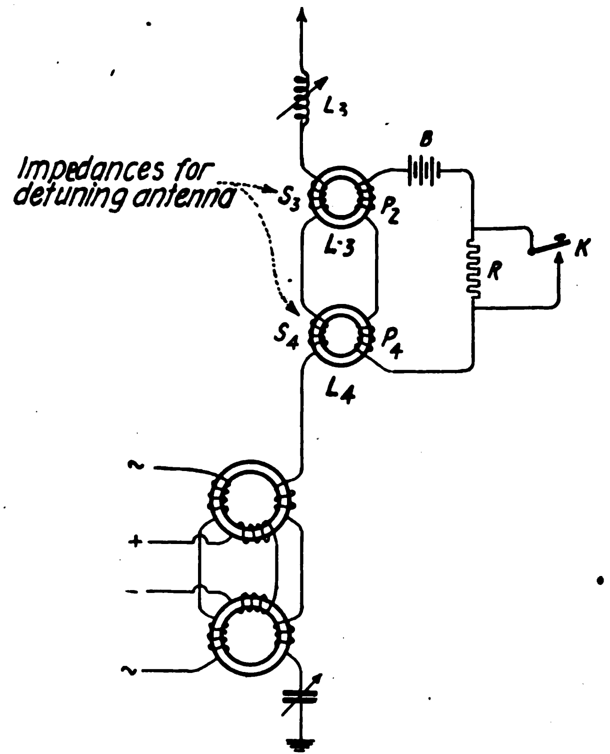


Figure 12—Diagram of a simple system for varying the antenna current

While this method of control possesses operative features, it still carries the disadvantage that circuits carrying high frequency currents of considerable power are actually interrupted. However, by providing mono-inductive impedances for the purpose of detuning, it is possible to adjust the auxiliary magnetising current so that no actual interruptions of the high frequency circuit are required to shift the load from the antenna to the auxiliary loading circuit. Such a system is shown in the diagram of connections in figure 13, but before entering into a description of this system we shall disclose another method of connection whereby the antenna current can be varied in a simple manner. The diagram therefor is shown in figure 12, where two one-way impedance coils L-3 and L-4 have their secondaries S-3 and S-4 respectively, connected in series with the antenna circuit. Their primaries P-2 and P-4 are fed by the direct current source B, the circuit including the key K and the shunt resistance R. Just how this circuit functions will be clear from consideration of the resonance curve shown in figure 11 where the current through the windings S-3 and S-4 is plotted against their self-induction, variation of which is obtained by change in the value of the direct current through P-2 and P-4.

If the impedances S-3 and S-4 are properly designed, it is clear from the curve that a very small variation of the magnetising current will cause a large change in their self-induction. The change of inductance may then be selected so as to completely detune the antenna circuit. The resistance R is of such dimensions that when it is not short-circuited, the direct current is decreased to a value so that the antenna is detuned by change of impedance and accordingly very little energy is withdrawn from the radio frequency changers. When the key is pressed the self-induction of S-3 and S-4 is reduced so as to tune the circuit, the antenna radiating at the frequency of the frequency transformers. It is obvious that a microphone could be inserted in the circuit instead of the key K and speech signals transmitted as in ordinary wireless telephony.

The windings S-3 and S-4 are so disposed on their cores that one-half cycle of the generator output is impeded by one impedance and the other half-cycle by the other impedance. Sufficient modulation could be obtained by the use of one coil, but for wireless telephony it is desirable that both halves of the complete cycle be prevented from flowing in the antenna circuit.

In case an auxiliary loading circuit such as previously shown in figure 9 is connected with the radio frequency changers, the two one-way impedances may be used for alternately tuning and detuning the antennna and the loading circuit, that is, the load is alternately shifted from one to the other. The diagram of connections is shown in figure 13 where the one-way impedances have their secondary windings S-3 and S-4 in series with the antenna and with the secondary windings S-5 and S-6 of the radio frequency changers. The complete antenna circuit is shunted by the load circuit, including the ballast resistance R, the variable capacity C-1 and variable inductance L-1 which constitute an auxiliary loading circuit. As usual the primaries of S-4 and S-3 are energized by the source B in series with key K shunted by the resistance R. The antenna inductance is indicated at L-4 and the series variable condenser at C-3.

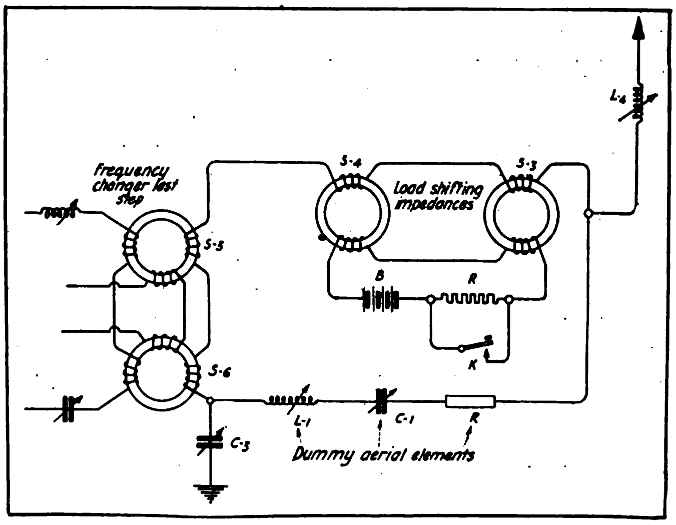


Figure 13—Mono-inductive impedances for detuning the antenna circuit and transferring the load to a dummy aerial

It is clear that by proper design of the auxiliary loading circuit, and careful adjustment of the D.C. magnetization of the cores of S-4 and S-3, a combination can be effected whereby when the key is closed the change in the self-induction of S-3 and S-4 will tune the antenna circuit to resonance with the alternator and at the same time will place the circuit S-3, S-4, S-5, S-6, L-1, C-1, R out of resonance with the alternator. On the other hand, when the key is raised the self-induction of S-4 and S-3 will be varied by such an amount as to place the auxiliary circuit in resonance with the generator simultaneously detuning the antenna circuit thereby maintaining a constant load on the generator.

A particularly effective arrangement for tuning and detuning the antenna and the loading circuit is to

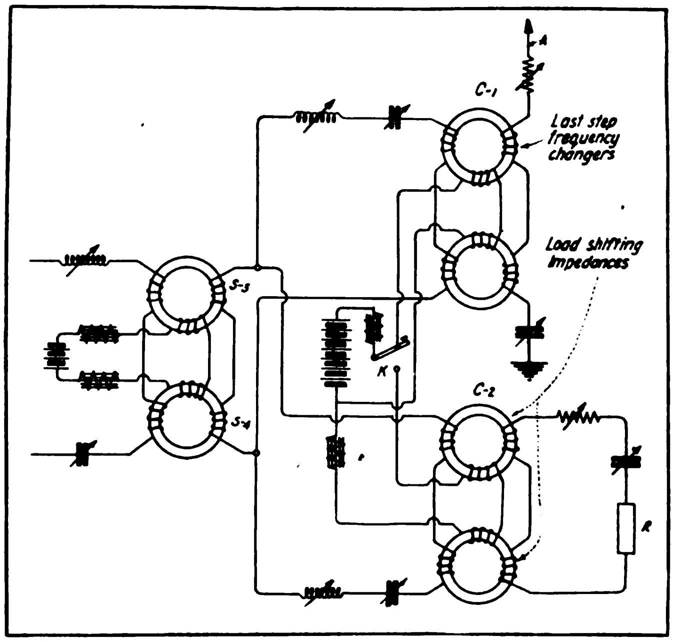


Figure 14—Special load shifting circuit

employ the auxiliary magnetising circuit of the frequency changer as shown in figure 9. The yokes Y-1 and Y-2 of the group of radio frequency changers, in addition to the secondary windings S-3 and S-4, carry the windings S-5 and S-6 which are part of the auxiliary loading circuit comprising the inductance L-1, the variable condenser C-1 and the ballast R. This circuit also includes key K-2. If the current intensity of the magnetising circuit is varied by operating the key K-4 (shunting the resistance R-3) the antenna may be automatically tuned when the key is closed and the auxiliary loading circuit may be tuned and the antenna detuned when the key is open. This circuit, however, operates with the disadvantage that through variation in the direct current intensity, the energy output of the frequency changer is varied so that it is difficult to maintain the output constant for necessary resonance.

This fault may be corrected by employing the connections shown in figure 14, where the second last frequency changer group is connected at its secondary windings S-3 and S-4 with two frequency changers, both being connected in parallel to the last group. The group C-1 discharges its current into the antenna A and the group C-2 is connected with a non-radiating circuit including the load R.

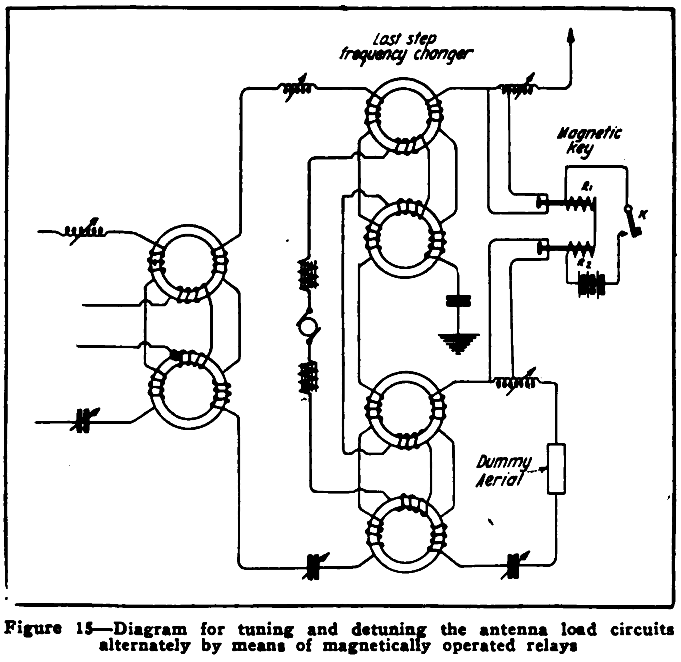


Figure 15—Diagram for tuning and detuning the antenna load circuits alternately by means of magnetically operated relays

If the group C-1 and C-2 are of uniform dimensions, the load of the generator and that of the changer groups C-1 and C-2 remain constant if one or the other of the two parallel sets is thrown into operation. These sets are alternately operated by changing the auxiliary magnetising current from one set to the other by means of a key K fitted with double contacts.

In place of this key a relay such as shown in figure 10 operated by an auxiliary circuit and an ordinary key may be employed. In this case, satisfactory operation is secured by weakening the direct current as has already been shown in figure 13, but this must take place alternately in sets C-1 and C-2.

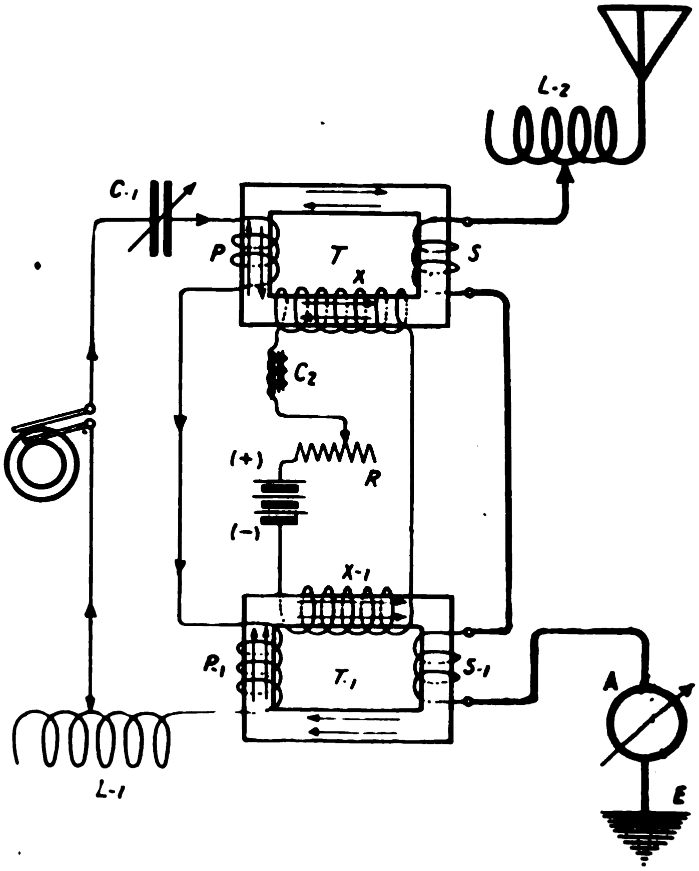


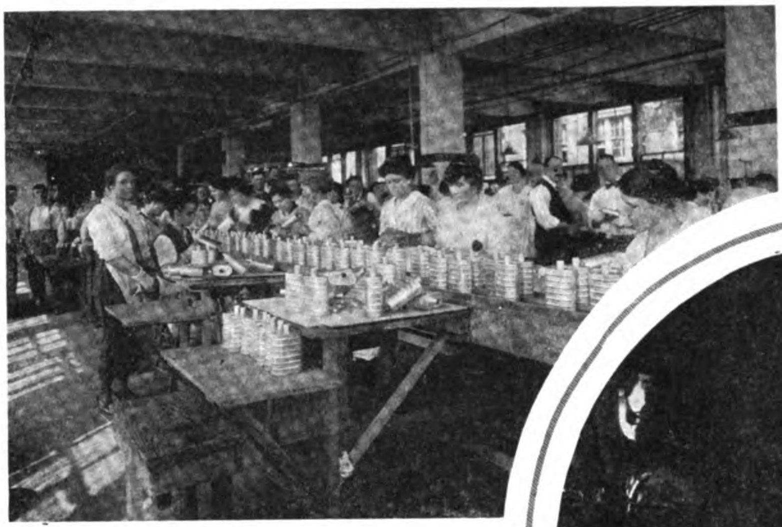
Figure 16—Fundamental wiring diagram of a single step radio frequency changer. The primaries of the transformers T and T-1 are mono-inductive, their cores being saturated by excitation windings X and X-1. When in either transformer the flux generated by the current from the alternator opposes the flux of the excitation winding, a complete cycle of current is induced in the secondary winding. In the diagram, transformer T is active, transformer T-1 inducing no current in the secondary winding S-1 because the fluxes are in the same direction and the core is saturated by the D.C. source

The only objection to the parallel arrangement of these two sets is that when the circuits in which they discharge their energy are detuned, the primary current rises to an excessive value which in some cases may completely upset the working of the apparatus. This may be overcome by arranging groups C-1 and C-2 in a series connection with the preceding group as shown in figure 15. In this case the tuning and detuning of two circuits is obtained by means of magnetically operated relays R-1 and R-2 as shown in connection with a previous diagram.

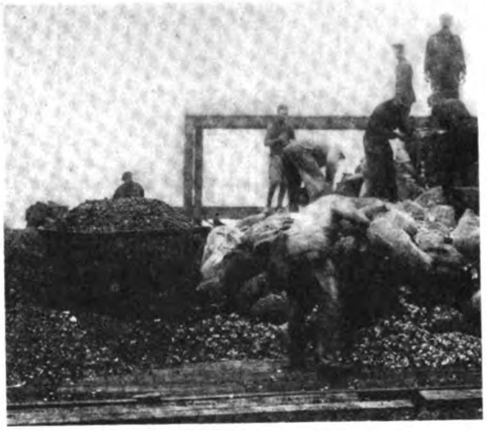
(*To be continued*)

Gas Masks

A Triumph of Science



Factory inspection of the carbon and chemicals which are contained in the respirator canister



Photos: Press Ill. Svce.

Above, in circle, the great retorts wherein the fruit pits are changed into charcoal

At the left, piles of fruit pits on the docks being loaded for transportation to tne furnaces to be turned into charcoal, which, with chemical compounds, has made poison gas harmless

The finished product in use; a drill which requires adjustment of the masks in six seconds

Practical Wireless Instruction

A Practical Course for Radio Operators

By Elmer E. Bucher

Director of Instruction, Marconi Institute

PART II—ARTICLE II, OF WARTIME WIRELESS INSTRUCTION

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EDITOR'S NOTE—Part 1 of this series of lessons began in the May, 1917, issue of THE WIRELESS AGE. Successive installments were devoted to the fundamental actions of radio transmitting and receiving apparatus for the production and reception of damped oscillations.

Part 2, the present series, will deal with undamped wave generators, including bulb transmitters and receivers for the reception of undamped oscillations. The direction finder and other special appliances employed in radio telegraph work will be treated fundamentally. A discussion of the basic principles of wireless telephony will terminate the series.

The outstanding feature of the lessons has been the absence of cumbersome detail. The course will contain only the essentials required to obtain a government *first grade commercial license certificate* and to supply the knowledge necessary to become a first rate *radio mechanic*.

RADIO FREQUENCY ALTERNATORS

(1) The direct generation of radio frequency currents in dynamos has been accomplished. Such dynamos are generally termed **radio frequency alternators.**

Radio frequency alternators may be classified as follows:

- (a) **The type in which radio frequency currents up to 100,000 cycles per second are generated by an armature rotating at very high speed-up to 20,000 R.P.M.**
- (b) **The type in which radio frequencies below 50,000 cycles per second are generated by a normally low speed alternator at shaft velocities up to 3,500 R.P.M.**
- (c) **The type in which frequencies are multiplied in the same machine—the armature rotating at comparatively low speeds. In this type the frequency is multiplied by the "reflector" principle.**
- (d) **The type in which a comparatively low speed armature generates currents from 5,000 to 15,000 cycles per second, the frequency being further multiplied by external mono-inductive radio frequency transformers.**

Examples of (a) and (b) are the **Alexanderson** high speed and low speed **radio frequency alternators.** An example of (c) is the **Goldschmidt reflector alternator.** Examples of (d) are the **Joly-Arco** and the **Arco-Meissner systems.**

COMMERCIAL UTILITY

(2) None of the aforementioned systems have been employed extensively in commercial radio communication, but some promising results have been obtained in experimentation. All four types with the possible exception of the Arco-Meissner system **are not adapted for transmission on the shorter wave lengths below 2,500 meters.** These systems therefore require aerials of rather large dimensions, the use of which is not possible on vessels of small tonnage. They have proven feasible, however, for long distance land station transmission at fixed wave lengths.

(3) The design of high speed radio frequency alternators involves advanced mechanical and electrical problems, chief among them being

- (a) **The high peripheral velocity of the rotor.**
- (b) **The limited space available for the stator windings consistent with a rotor of small diameter.**
- (c) **The expenditure of extraordinary driving power to overcome air friction.**
- (d) **Special design of the bearings to withstand high speeds.**

It is essential that the iron and copper losses and magnetic leakage be reduced to a minimum.

To reduce heating losses due to hysteresis, the stator and rotor supports are made of fine iron laminations. Artificial cooling means must be provided. For example, in one system refrigerated air is supplied to the rotating armature and in another system the radio frequency alternator is specially designed for water cooling.

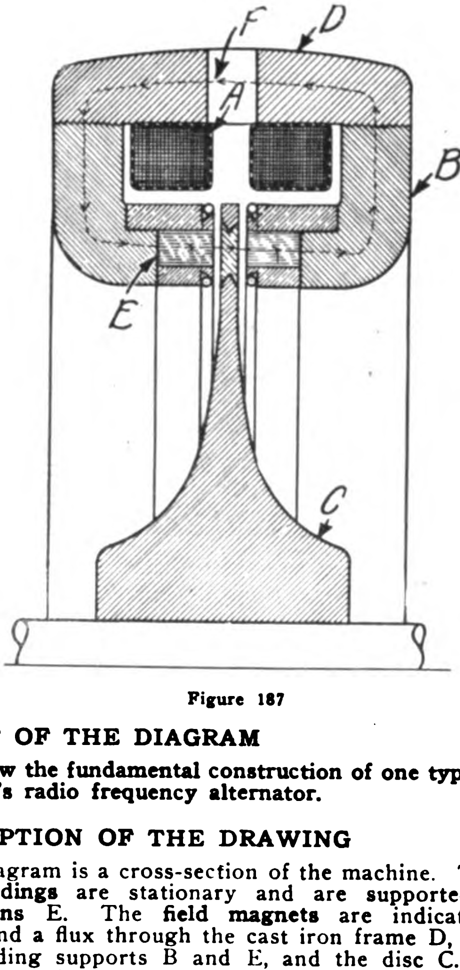

Figure 187

OBJECT OF THE DIAGRAM

To show the fundamental construction of one type of Alexanderson's radio frequency alternator.

DESCRIPTION OF THE DRAWING

The diagram is a cross-section of the machine. The **armature windings** are stationary and are supported by the **laminations** E. The **field magnets** are indicated at A which send a flux through the cast iron frame D, the armature winding supports B and E, and the disc C. The air gap between the armatures and the disc C can be carefully regulated for maximum efficiency.

The circumference of the disc C is provided with **slots** which are milled through the rim. The remaining spokes of steel are filled between with **phosphor bronze lugs** which are riveted in place to withstand the high armature velocity and are trimmed down to provide a smooth surface to reduce air friction.

The standard 100,000 cycle rotor is made of chrome-nickel steel with 300 slots.

The shaft of the alternator is long and flexible permitting the rotor to find its center and thereby avoiding extensive shaft strains.

The armature coils consist of **U shaped windings.** Two consecutive U formed wires may be considered **as a pair of** coils of one turn each joined in series.

(*Continued on page* 25, *first column*)

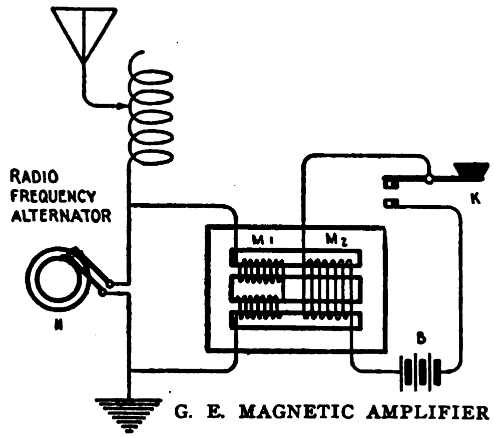

Figure 188

OBJECT OF THE DIAGRAM

To show the fundamental circuits of the Alexanderson magnetic amplifier for controlling the output of a radio frequency alternator and therefore the magnitude of the antenna current.

DESCRIPTION OF THE DRAWING

A specially constructed iron core transformer has the parallel windings M-1 wound oppositely on the two legs of the core as shown. The terminals of M-1 are connected to the radio frequency alternator N. The control winding M-2 includes both legs of the core of M-1, DC current being supplied by the battery B.

OPERATION

If the key K is closed, DC current from the generator or battery B saturates the core magnetically and the inductance of the windings of M-1 will be that secured without an iron core. On the other hand, if the key K is open, the iron core is saturated by the winding M-1 and its self-induction is then maximum. It is thus seen by closing the key K that the current generated by the alternator is withdrawn from and fed to the antenna circuit to form the dots and dashes of the telegraph code.

SPECIAL REMARKS

(1) If a **microphone transmitter** is connected in the control circuit of M-2 the reluctance of the magnetic circuit of M-1 is varied at speech frequency and the magnitude of the antenna current varied accordingly.

(2) Inasmuch as the two branches of winding M-1 are wound relatively opposite to M-2, one branch will oppose the ampere-turns of M-2 on one-half cycle of the radio frequency current, and the other branch during the next half cycle.

(*Continued from page 24*)

OPERATION

The magnetic flux set up by the field poles A has the direction indicated by the arrows. When a tooth on the rotor comes opposite the armature B, flux passes through the coils B, and as the rotor revolves the non-magnetic material between spokes occupies the same position, whereupon the path of the flux is broken. Currents of radio frequency are thus induced in the windings B, the terminals of which may be connected directly to the aerial and earth wires of a complete transmitting system.

SPECIAL REMARKS

(1) The terminals of the radio frequency alternator may be connected to the earth and aerial directly. It is preferable, however, to place a **step-up** or **step-down transformer** between the aerial and generator.

(2) When the terminals of a radio frequency alternator are connected to the aerial and earth directly, a rise in voltage takes place so that the E.M.F. in the alternator may approximate from 2,000 to 3,000 volts.

(3) Alexanderson has eliminated this phenomenon by providing an **air-core radio frequency transformer between the alternator terminals and the antenna.** For example, in one design the primary winding had 32 distinct coils connected in parallel to 32 different circuits leading from the stator windings of the alternator. A variable connection from the secondary is attached to the antenna to provide voltages suitable to aerials of different characteristics.

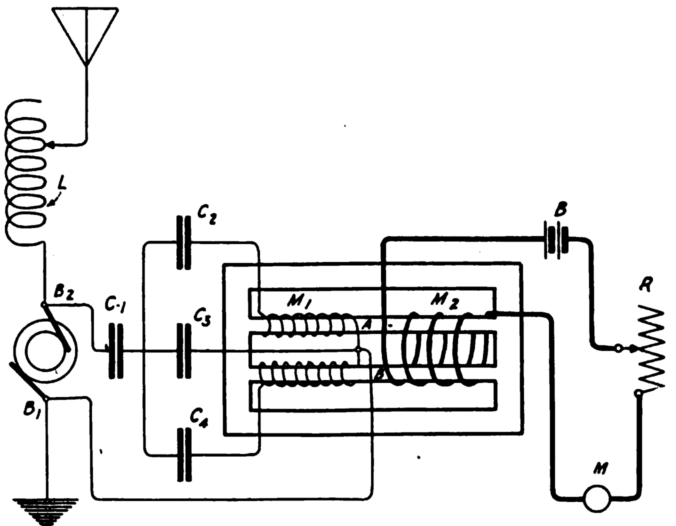

Figure 189

OBJECT OF THE DIAGRAM

To show the complete circuits of Alexanderson's magnetic amplifier for obtaining large modulations of antenna current at audio frequencies with a minimum of control current.

DESCRIPTION OF THE DRAWING

The brushes B-1 and B-2 of the radio frequency alternator are shunted by the AC windings M-1 of the magnetic amplifier.

Coils A and B of M-1 **are connected in parallel** and in magnetic opposition.

Condensers C-2 and **C-4** are in series with branches A and B respectively, and **condenser C-1** is in series with impedance M-1 to minimize its reactance and to permit a linear control of the current diverted from the antenna system through M-1. M-2, the DC control winding includes the legs of both branches of M-1. **DC excitation current** is supplied by battery B in series with which is the regulating resistance R. M may represent a **microphone transmitter** or a **telegraph key,** or the current in M-2 may be controlled by a **vacuum tube relay.**

OPERATION

It must be remembered that the object of the magnetic amplifier is to modulate the antenna circuit at **audio frequencies** either for **wireless telephony** or **telegraphy.** This modulation is effected by diverting the current from the antenna circuit through the turns of M-1 by variation of its impedance. For the best operation it is essential that the ampere turns of M-2 approximate those of M-1. Variation of the DC excitation current causes a marked variation in the self-induction of M-1 and accordingly the voltage drop across the alternator. By the addition of the several condensers in the circuit shown, a very sensitive control of the impedance of winding M-1 is obtained with a minimum of excitation current in the control winding M-2. As a general explanation of the phenomenon of the amplifier it may be said that if the core is saturated by M-2 the **self-inductance of M-1** is that of a **simple winding without an iron core,** and, therefore, the current through M-1 or in other words, the voltage drop across the alternator is relatively great; but with zero DC current in the coil M-2, the **self-induction of M-1 is maximum** and the flow of current from the alternator through M-1, relatively small. Some of the relations between excitation-current, alternator E.M.F., and corresponding current flow through M-1 will be shown in the curve to follow.

With the connections of figure 189 applied to a particular set of his design, it was shown by Alexanderson that a current of **0.2 ampere turned on and off in the coil M-2 caused the output of a 50 kw. radio frequency alternator to vary between 5.8 kw. and 42.7 kw.**—a variation of 37 kw.

Special Remarks

(1) The branches of M-1 in figure 189 are in parallel instead of in series as in figure 188.

(2) This connection gives a lower impedance, which, with a certain control current in M-2 gives greater sensitiveness and permits the handling of large currents without arriving at an undesirable condition of instability of operation.

(3) The effect of the condensers C-2 and C-4 is as follows: If the branches A and B were in parallel without condenser C-2 and C-4 in series as shown in this diagram, and the control current in M-2, for example, was varied at an audio frequency, there would be produced a short circuit current between the branches A and B. without producing any flux variation for the radio frequency current; but since the branches A and B

need carry only radio frequency current, condensers C-2 and C-4 are chosen of suitable value to act as a short circuit for the radio frequency current and an open circuit for the audio frequency current generated by the control winding M-2.

(4) The condenser C-1 increases the sensitiveness of the entire system so that a very much smaller DC control voltage is required to vary the output of the alternator. This condenser also permits a linear control of the antenna current; that is, a control whereby the antenna current varies directly with the amplitude variation of the current in the control circuit M-2. Such control is necessary for perfect speech reproduction in radio telephony.

If the capacity of C-1 is selected to neutralize the inductance of M-1 for some definite value of control current in M-2, the impedance of the alternator shunt circuit becomes a minimum. For any lower value of control current, the impedance is determined by the difference between the inductive reactance of coil M-1 and the capacity reactance of C-1. The smaller the difference between these two values of reactance the lower will be the control current required to reduce the alternator voltage to a minimum. In other words, a very slight variation in the DC control current will cause a very great drop of E.M.F. across the alternator and therefore will vary the antenna current in accordance.

(5) Still better control of the alternator output is obtained by providing a shunt condenser C-3. Its value is so chosen that the current through the amplifier at low excitation will be a leading current instead of a lagging current. The condenser, therefore, permits the alternator to assume its full maximum voltage.

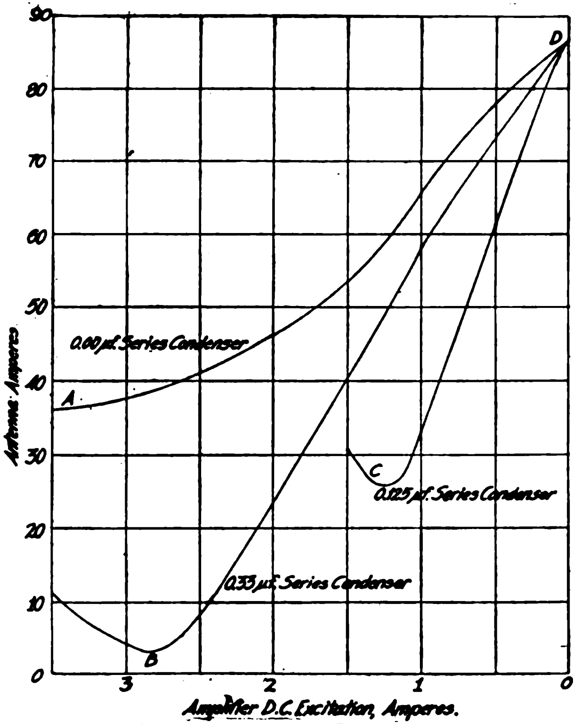

Figure 190*—Showing how condenser C-1 in figure 189 increases the sensitiveness of the magnetic amplifier. The horizontal axis shows the DC excitation current and the vertical axis the actual antenna current. It is clear that with the condenser of .33 microfarads and with DC excitation current less than 2.8 amperes, the change in antenna current is very much greater than with the other two values of capacity shown. Besides a linear control of the antenna current is secured

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*Taken from "Radio Telephony" by Dr. Alfred N. Goldsmith.

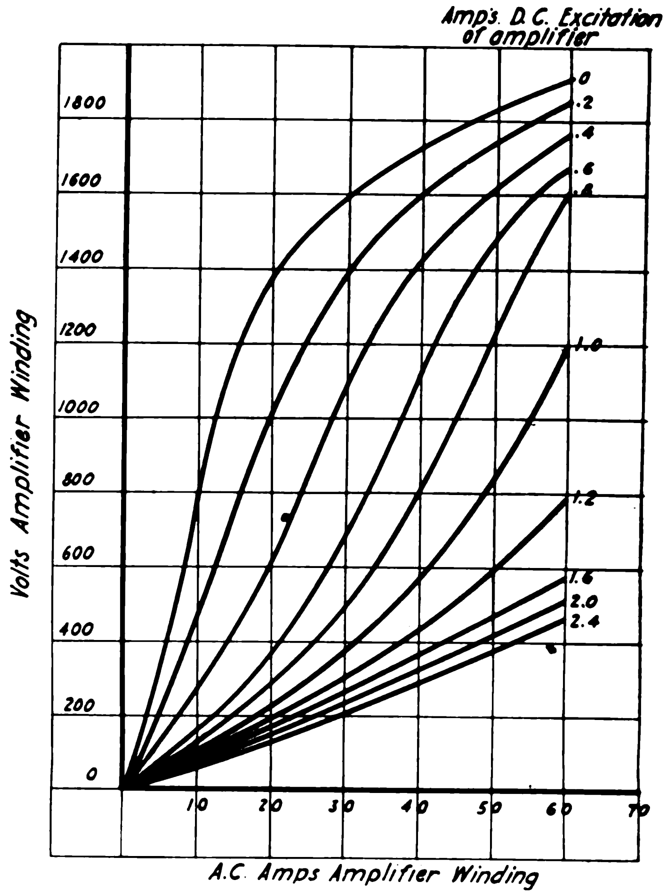

Figure 191*—Showing how the impedance of the magnetic amplifier varies with different alternator voltages and different values of DC excitation current in the control winding of M-2, figure 189

For example, at 800 volts the current through the amplifier varies from 10 amperes for zero current in the DC control circuit to 60 amperes for 1.2 amperes in the DC control circuit. In other words, if a telegraph key be inserted in the DC control circuit of figure 189 and the magnetizing current in M-2 be varied from zero to 1.2 amperes the alternator output would change between 60 and 10 amperes and there will be a corresponding change of current in the antenna circuit

Again at 1200 volts, the current through the amplifier varies from 15 amperes for zero DC control current to 60 amperes for 1 ampere DC control current; and at 800 volts the current from the amplifier varies to 10 amperes for zero DC control current to 33 amperes for .6 amperes DC current. It is clear that with a given alternator and amplifier, some combination of DC current and alternator voltage can be selected whereby a ridiculous small value of DC excitation current can cause an extremely large variation in the output of the alternator. Particularly so, if the capacities of the condensers shown in figure 189 are properly chosen

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*Shown by Alexanderson in volume 4 No. 2, Proceedings I.R.E., April, 1916.

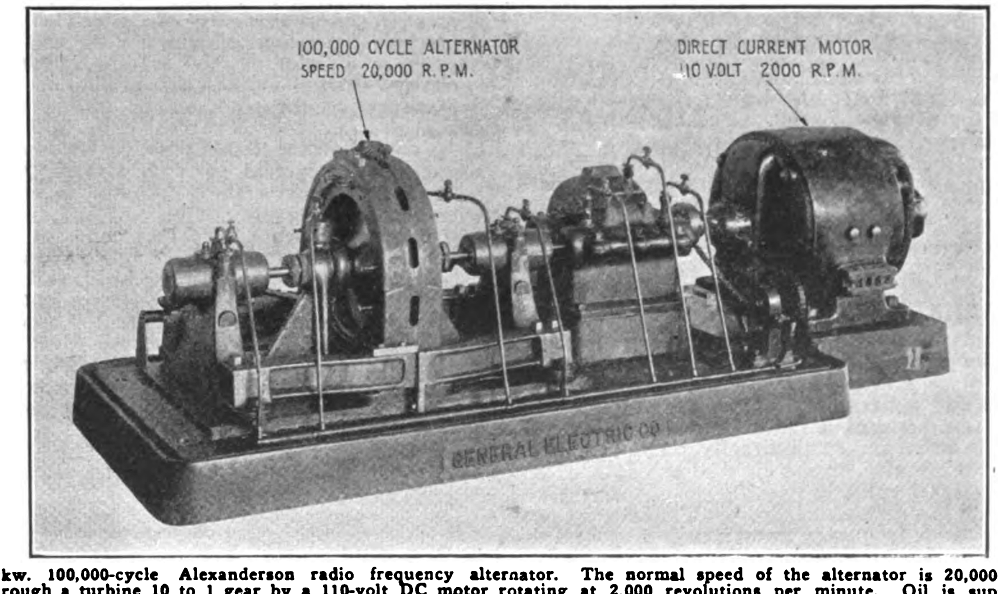
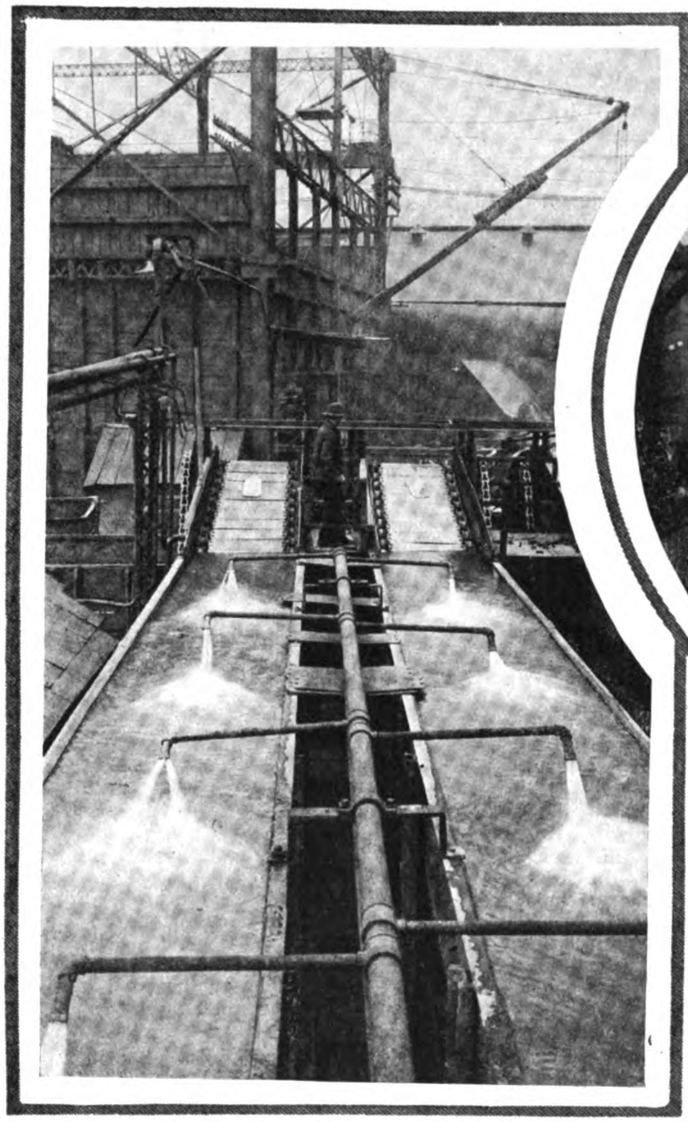
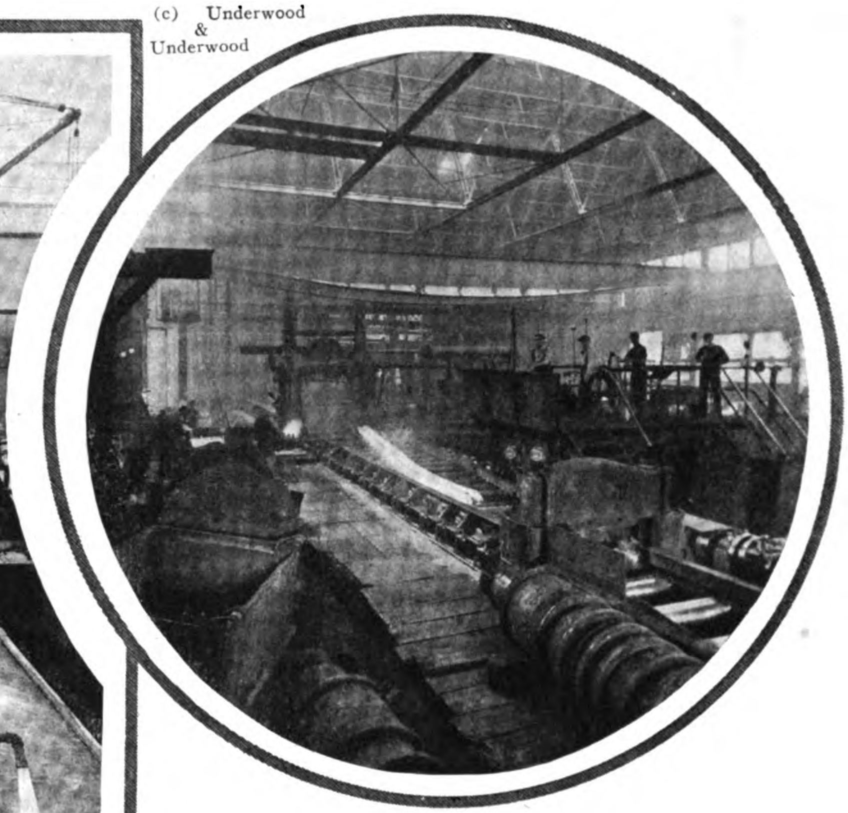


Figure 192—The 2kw. 100,000-cycle Alexanderson radio frequency alternator. The normal speed of the alternator is 20,000 revolutions per minute. It is driven through a turbine 10 to 1 gear by a 110-volt DC motor rotating at 2,000 revolutions per minute. Oil is supplied to the bearings under pressure and a special cutout valve is attached to the oil pipes, which if the oil stops flowing, trip the circuit breaker in the DC line thereby protecting the generator bearings. To prevent binding of the thrust bearings, the generator is provided with a system of equalizing levers which compensate for shaft heating

The output of these alternators is approximately 10 amperes at 200 volts or 20 amperes at 100 volts, depending upon the load and the mode of connection between the armature and the output circuit. The inductance of the armature is .08 microhenries, the armature resistance 1.2 ohms at the frequency of 100,000 cycles

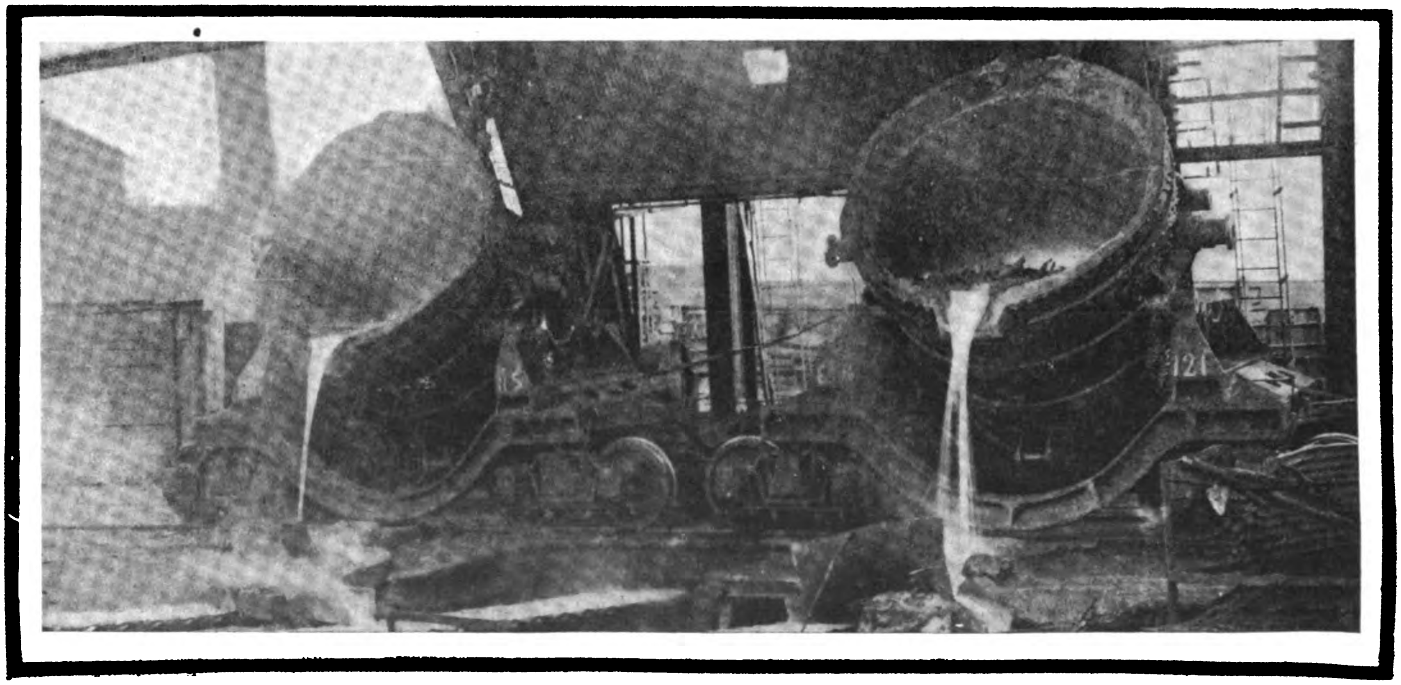


(c) Underwood & Underwood



Steel for France

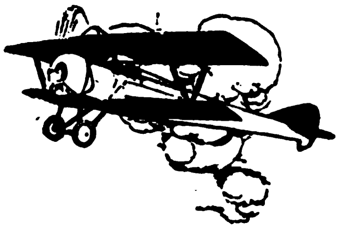
How the United States has turned its commercial genius from making war to preparing for rebuilding devastated countries overseas, is illustrated in these three views of one industry's activities. Above, in circle, is seen a rolling mill interior with a rail emerging for eventual use in transporting material and supplies through Flanders and Lorraine. At the left, pig iron on belt conveyors passing through the cooling troughs



Speed, and yet more speed, is the eternal cry of those who make the steel for the victorious nations. Here is shown the start of the operation revealed above; the giant ladles pouring molten metal into the moulds which the belt conveyors carry directly to the cooling troughs

How To Become An Aviator

The Seventeenth Article of a Series Giving the Elements of Airplane Design, Power, Equipment and Flight Problems



By J. Andrew White
and Henry Woodhouse

(*Copyright,* 1918, *Wireless Press, Inc.*)

Laying Off a Course

DETERMINING THE STEERING DIRECTION

It is obviously important for the aviator to know the direction to head his machine to arrive at a given destination. When flying above clouds, over water, or at night, when landmarks are not discernible, he has no means of determining how far the wind may be blowing him off his course. Calculations are therefore made in advance by the following method:

DATA REQUIRED:

Flying speed of his airplane.
Compass bearing of his course from point of departure to destination.
Direction and speed of the wind.

The map of the country over which he is to fly will give him the compass bearings; the points joined by a line (see Figure 106) determine the direction and its angle to the north of the compass bearing.

Direction and speed of the wind can be found from the weather vane and anemometer of the airdrome. The anemometer is a device with four arms carrying cups on the end of each, turning about on a vertical axis at a speed varying with the wind velocity. When the wind velocity at the ground has been determined, the aviator must decide upon the height at which the flight is to be made, for as height increases the velocity and direction of the wind changes. The table below will be found useful in estimating the proper allowance:

Wind Velocity and Direction Changes with Altitude
(Based on Wind Velocity of 25 miles per hour)

Height in feet	At the earth's surface	500′	1000′	2000′	3000′	4000′	5000′
Velocity change in per cent.	100%	135%	172%	188%	196%	200%	200%
Clockwise deviation in degrees	0	5°	10°	16°	19°	20°	21°

Example: Assume that the anemometer shows a wind velocity of 25 miles per hour at the ground, and the weather vane indicates the direction of the wind 89° west of north. The aviator plans to fly his course at a height of 3,000 feet. From the table he learns that the wind velocity at this altitude is 196% greater than at the ground; then, $25 \times 1.96 = 48$ miles per hour. Likewise, from the table, it is seen that the wind direction at this altitude shows a clockwise deviation of 19°, so at 3,000 feet the direction of the wind will be $89° — 19° = 70°$ west of north.

A DIAGRAM TO DETERMINE THE WIND FACTOR

With the data in hand the aviator can lay out a simple diagram for his course. Assume that his orders call for a flight from Fort de Villeneuve to Bougy (see *A-B*, figure 106). The route, according to the map, is 30° east of north. The speed of the aviator's airplane is 80 miles per hour. The wind, as already determined, has a velocity of 48 m.p.h. in a direction of 70° west of north at 3,000 feet, at which height the flight is to be made.

Either on the map or on a separate sheet of paper, the starting point is designated *A* (see figure 107). A line is then drawn with the proper compass bearing to the destination *B*. From point *A* a line is drawn parallel to the direction of the wind, blowing 70 degrees west of north. On this line the velocity of the wind is measured off, the aviator establishing a scale, say 1 inch = 10 miles, *or any other convenient scale.* Assume that the scale 1 inch = 10 miles is the one selected; then 48 m.p.h. would be measured, 4.8 inches to point *C*. With a pair of dividers opened to represent the speed of the airplane by the same scale (in this case, 80 m.p.h. = 8.0 inches) an arc is described with *C* as the center. Where it cuts the line *A-B* (see *D*, figure 107) a line is drawn from *D* to *C;* this line gives the proper direction to steer the airplane to neutralize the drift of the airplane in one hour's flight from *A* to *B* in the cross wind. The steering is by compass bearing to the fore and aft axis of the machine.

Measurement of the line *A-D*, applied to the scale will give the actual velocity in miles per hour of the flight. In the example it is seen to be 85 m.p.h., that is, the cross wind increases the airplane's speed 5 miles per hour.

The student should reconstruct the diagram for the return flight. That it will not do to steer in exactly the opposite direction will then be made clear. In all cross-country flights a separate diagram for the return is required, unless, of course, the wind happens to be exactly parallel to the course.

RADIUS OF ACTION

To determine the distance outward the airplane can go and have sufficient gasoline to return, requires a simple calculation.

The aviator knows his gasoline capacity; i.e., how many hours of flight can be obtained before the tank is empty. With this and the other data he can figure his radius of action in miles.

Example: Assume that the flight is to be made straight into a head wind of 30 miles per hour, the speed of his airplane is 80 m.p.h., and its gasoline capacity 4½ flight hours. (For climbing and as a general margin ½ hour gasoline consumption is deducted, leaving 4 flight hours.)

On the outward trip his speed is $80 — 30 = 50$ m.p.h.

On the return trip his speed is $80 + 30 = 110$ m.p.h.

The ratio for both trips is, then, as 50 is to 110, or 5 is to 11. The time required for the outward trip is thus 11/16 of 4 hours, and the return trip the remaining 5/16 of 4 hours; or, outward = 2¾ hrs.; return = 1¼ hrs. Since his outward bound speed is 50 m.p.h., then $50 \times 2\frac{3}{4} = 137\frac{1}{2}$ miles radius. Return speed being 110 m.p.h., then $110 \times 1\frac{1}{4} = 137\frac{1}{2}$ miles. This, then, is the radius of action.

A wind blowing directly along the course is a rare occurrence, however. A diagram similar to figure 107 must therefore usually be made, both for the outward and return trips. The calculation for radius of action is then carried on as above, or by the simple formula:

$$\text{Radius of Action} = a \times \frac{b \times c}{b + c}$$

Where
a = gasoline hours.
b = outward speed.
c = return speed.

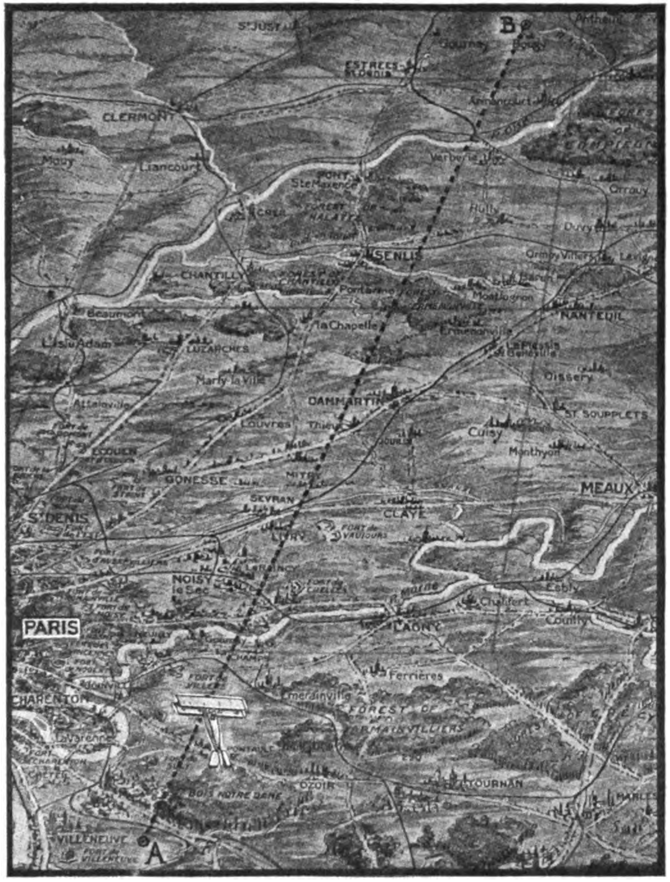


Figure 106—How an airplane must be steered off the direct course to allow for side wind drift

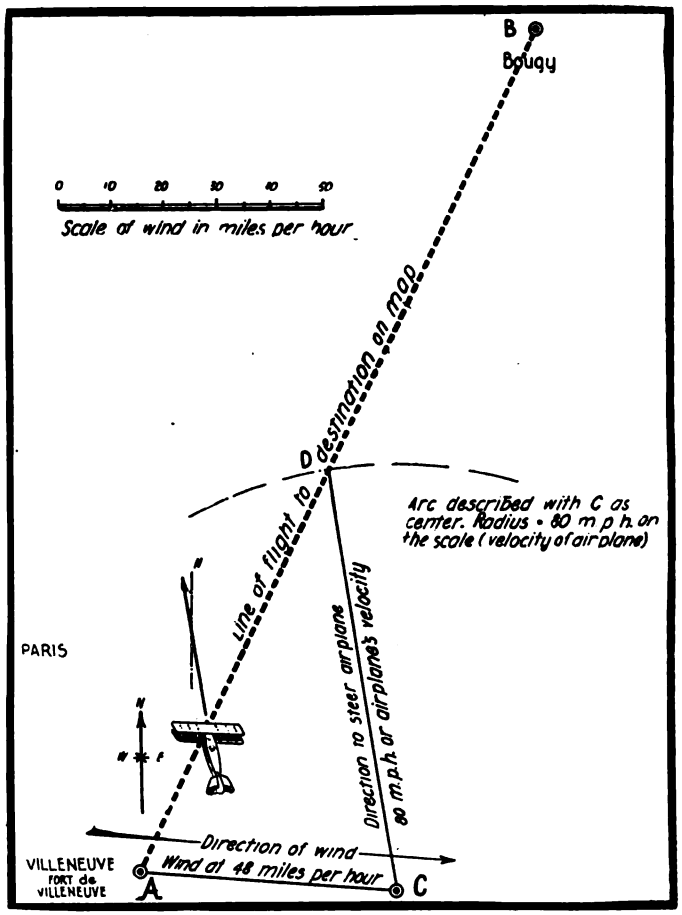

B
Bougy
0 10 20 30 40 50
Scale of wind in miles per hour
Line of flight to destination on map
D
Arc described with C as center. Radius = 80 m p h. on the scale (velocity of airplane)
Direction to steer airplane
80 m.p.h. or airplane's velocity
PARIS
N
W E
Direction of wind
Wind at 48 miles per hour
VILLENEUVE
FORT de VILLENEUVE
A
C

Figure 107—Diagram solution of the flight from A to B shown in figure 106

SOME FLIGHT CONSIDERATIONS

PROPER PREPARATION

Care must be observed by the aviator that his preliminary preparations are properly made. This refers particularly to a study of the course from the map.

Ordinarily the country over which he is to make the flight will be on one sheet with features and landmarks clearly indicated. Should the use of two sheets be necessary these should be pasted together before starting and cut to fit the map roll. In war flights foreign maps with the scale in fractions are often the only ones available; the aviator should immediately construct the corresponding scale at so many miles to the inch, which will facilitate rapid calculation. Distances from the starting point should also be marked at ten mile intervals or by distinctive objects to be passed. High hills should be marked as bad for landing.

HEIGHT

Where there are no high hills or mountains in friendly territory the flight is best made at heights from 1,500 to 3,000 feet. An altitude of 1,500 feet should be attained by an initial circling climb before the aviator sets off on his course. Speed and steadiness of wind increases with height, and landing or righting in case of mishap is better accomplished with a good margin; but above 2,000 feet contour of the country is not readily distinguished, so if the flight is to be at a higher altitude the poor landing places should be clearly marked on the map. It is well for beginners to keep the ground in view throughout the flight, flying under or around any clouds.

CLOUDS, FOG AND STORMS

Pupils are cautioned to avoid heavy cloud banks and not to rise above clouds when near the seacoast for a wind off shore may carry the airplane out to sea without the pilot's knowledge. When navigation above a cloud bank is necessary, the cloud formations may be used as a basis for keeping the airplane horizontally level, for cloud formations are ordinarily sufficiently level for this purpose. Fog should be avoided; in fact, when a heavy mist is encountered a landing should be made as soon as possible. River valleys should be avoided, for they very often hold a ground fog up to a height of 700 feet. At times when the flight must be continued through clouds or fog, the instruments should be carefully watched and the stick control and rudder kept in central position as much as possible. Heavy rain, sleet and hail chip the propeller slightly and when encountered a landing should be made at the earliest favorable opportunity. A whistling sound indicates that the propeller has been chipped.

AIR DISTURBANCES

Initial cross-country flights by the student are usually made under favorable weather conditions, ordinarily in the early morning or late evening, when the atmosphere is calmest. Bumps caused by heat, as explained in a later chapter on meteorology, manifest themselves early in the day as close to the ground as 100 feet; their influence is gradually extended upward as the morning progresses until they are perceptible at noon at altitudes up to 3,000 feet. Clouds and inland waters generally predict bumps, while over the sea the air is ordinarily smooth, although of high velocity. Landings in strong, bumpy winds are best made with additional speed, caution being exercised when nearing the ground in sheltered spots as wind eddies may cause a sudden roll or a drop of 10 feet or so.

LOST BEARINGS

Should something happen to the compass and the aviator be unable to get his bearings, his wrist watch will be of assistance in locating the points of the compass. With the hour hand pointed to the sun, the point midway between the angle it makes with the numeral 12, points to the south. Thus, at 8 o'clock in the morning, with the hour hand pointed at the sun, the point midway in the angle formed by 8 and 12, i.e. 10 on the watch dial, will point to the south.

LANDMARKS

The principal landmarks of a map should be firmly fixed in the aviator's mind prior to the flight, memorized if possible. Experience has shown that the following features are the most useful:

Towns—These are the best guides and should be marked with a circle or underlined on the map. A village is sometimes difficult of identification; location of its church and its reference to the roads will aid in placing it. If flying below 2,000 feet altitude the aviator should not pass directly over the town as the heat from factory chimneys causes marked air disturbances.

Railways—Railroad tracks are of great assistance. Tunnels, bridges and cuts are marked on the map and aid in locating the line to be followed should the aviator mistake a branch line or siding for the main route. It should be remembered that the track disappears when it passes through a tunnel.

Water—Water courses and lakes are usually clearly defined and may be seen at some distance. Allowances should be made, however, for possible flooding of streams after heavy rains which may change their appearance as recorded on the map. The bearing of a river with reference to the course should be noted; following its windings may involve loss of time.

Roads—From a height all roads look very much alike and are therefore not very good guides. Main roads can occasionally be identified by the paving and the amount of traffic, and are useful because they lead into towns. Telegraph lines may be expected along them, which makes landing nearby dangerous.

Woods—Small forests serve as excellent guides.

Hills—From altitudes of 2,000 feet and over, hills are flattened out in appearance and valleys are not clearly discernible.

General Characteristics—The physical features of the country are very helpful to the aviator if his preliminary study of the map fixes in his mind their relationship to each other. How railways and streams join or intersect, how they enter and leave towns, and their relation to wooded areas, supply useful information. Dividing the course into four progressive parts also aids, if the general nature of each sector is noted for its chief distinguishing characteristics, whether water, woods, farm lands, towns or villages.

FORCED LANDINGS

Engine failure is the main cause of forced landings. As soon as it is known that the failure is complete, the engine should be switched off and the gasoline pipe closed to lessen the danger of fire. The airplane is then turned into the wind and if the ground directly beneath makes landing impossible the descent can be made in a long glide. While selection of landing ground is not practical from a recognition standpoint at altitudes greater than 1,000 feet, entirely unfavorable areas such as water, marshes or forests may be avoided by long glides. The radius of the forced landing is about five times the height at which the airplane is flying. An aviator forced to land from a height of 2,000 feet, therefore has about 10 square miles of land to choose from. At a height of 5,000 feet he has selection in an area of about 70 miles.

When a forced landing has been made the aviator's first thought should be for his machine and the immediate possibility of resuming flight. Examination of the engine is the first step; it should then be determined how much, if any, damage has been done to the airplane structure. A telephone call to his headquarters should then be made and a report given of his location and diagnosis of the trouble. If the damage requires staying where he is for the night, then the airplane should be moved to some spot sheltered from the wind and made secure.

TIME CHECKING

It is difficult to estimate time while flying, yet checking by the watch the time when successive objects are passed is an important detail often overlooked. The tendency invariably is to expect the next landmark long before it is due and confusion will arise in the aviator's mind unless time elapses are carefully checked. Knowledge of elapsed time is also valuable in steering a compass course over the clouds.

SELECTING LANDINGS

Choosing a suitable field to land in is by no means an easy task for the novice. A few primary rules governing selection will be useful.

It is better to pick out a *group of fields* as the glide may take the inexperienced aviator beyond or short of the mark.

Stubble fields, brown in color from a height, are generally smooth and, excepting sandy beaches, make the best landing ground.

Grass fields, green in appearance, often can be identified by cattle grazing. Mounds may be looked for in grass land, so they are therefore second choice.

Cultivated land is ordinarily fairly level, but landings made therein are successful only when pancaked. A ploughed field is black in appearance, vegetable and corn fields have a hue considerably darker than the green of grass lands.

A field *near a town* is the best choice, as its proximity to the source of supplies is a great convenience. The landing field selected, however, is preferably to windward of the town, so it will not be necessary to rise over the buildings when re-starting.

Telegraph wires usually border *main roads and railways;* these wires cannot be seen until the aviator is close upon them, so nearby landing places are undesirable.

When *snow* is on the ground the selection of a good landing place is practically impossible; the frozen ground, however, makes its selection of less importance.

Light variations are important. Flying into the rays of the sun, a slight haze appears which distorts objects. In the late evening, too, the light may be good at the flying altitude, but when descent is made the ground appears much darker. Before landing, therefore, a wide circle should be made until the eyes are accustomed to the relative dulness.

PEGGING DOWN

The airplane should be placed head into the wind and the tail lifted up and supported at a height which will place the airplane's wings edgewise to the wind. The controls should be locked and the wings and fuselage near the tail pegged down, some slack being left in the rope. The propeller, engine and cockpit should then be covered. If a strong wind is blowing, trenches should be dug for the wheels to a depth of about ¼ their diameter.

RE-STARTING

A minor trouble which does not require calling a repair crew may leave the aviator without assistance for starting, although spectators willing to hold back the airplane are generally more numerous than too few. Stones or fence poles will serve as chocks under the wheels if assistance is not at hand. Any mud which may be gathered on the wheels should be cleaned off as it will be drawn to the propeller by centrifugal force and chip or break it. Before starting, the ground over which the machine is to taxi should be walked over carefully and any serious obstacles removed. The possibilities of dead wind in the lee of buildings should be estimated and allowance made to get clear of these areas as the airplane rises. Small obstacles, such as hedges, may be cleared if good taxying speed is acquired and the control stick pulled back suddenly. Getting rid of extra weight will also aid the machine to take the air quicker, should there be doubt of getting out of the field.

Inventions the Army Needs

J. Andrew White, Editor THE WIRELESS AGE:

The Inventions Section of the General Staff of the United States Army has submitted to the War Committee of Technical Societies the attached problems requiring scientific and inventive talent for solution.

The War Committee, therefore, transmits this request of the General Staff to its membership and requests that the Engineers of America give them serious thought and consideration.

WAR COMMITTEE OF TECHNICAL SOCIETIES,
3549 NEW NAVY BLDG., WASHINGTON, D. C.

Ideas and suggestions should be submitted to
INVENTIONS SECTION, GENERAL STAFF,
ARMY WAR COLLEGE, WASHINGTON, D. C.

PROBLEM NO. I.—LIAISON COMMUNICATION

In operations of our troops fighting in France, all have seen the necessity of perfecting liaison between different elements of the command. This is especially true as regards liaison between elements of the front line troops and between front line troops and elements further to the rear.

Our infantry advances in spite of the most serious resistance offered by the enemy, and the losses suffered are necessarily heavy. These losses can be lessened by increased artillery activity. Liaison between the infantry is now maintained in so far as is practicable, by sending forward with the infantry a large artillery liaison personnel, well equipped with the material of liaison—telephones, wire, flags, projectors, rockets, radio, etc.

This personnel is charged with sending back information whereby fire may be directed on the hostile elements which are causing losses to our troops.

The present system of liaison does not always give satisfactory results. The enemy's fire frequently cuts off the infantry, and cuts regimental commanders from the units in the front lines. Wire is almost immediately cut by shells; optical signaling becomes impossible on account of smoke and dust, and frequently is interfered with by fog; runners become disabled or killed; pigeons go astray; radio is interfered with by enemy stations, and the antennae are destroyed by enemy fire; ground telegraph is limited in range, and interfered with.

The War Department is desirous of finding new means of communication whereby closer liaison may be maintained by the different elements of a command.

A device for this purpose should be small and compact, without antennae exposed to shell fragments; it should be easily transported by one man, or at the most by three men; it should be capable of being set up quickly, and not present a target to the enemy; it should operate over a distance of at least five miles and be certain of action.

It is believed that the War Department is in possession of the latest developments in so far as radio, telephony, signaling devices and similar apparatus are concerned, but is now seeking for something that is an improvement over all these devices. So far as known, nothing of the kind exists at present, but it is believed, with the inventive genius of the country concentrated along these lines, something desirable may be developed.

Problem No. II.—An Aviation Need

On night bombing expeditions and even in the daytime, when passing through fog or clouds, an airplane, like a ship, is guided entirely by a compass. Some of the new instruments designed for this work are beautiful examples of the instrument maker's skill, but, unfortunately, when placed where the aviator can see them, they are directly between him and the engine, a position which greatly affects their accuracy.

If a compass should be placed near the outer end of a wing, or at the rear end of the fuselage, it would be practically outside of the magnetic influence of the engine, but at present there is no way to read a compass in either of those positions.

What is needed is some device or arrangement whereby a compass can be mounted far enough away from the engine to be outside of its magnetic influence and still be so arranged that it can be easily read.

Problem No. III.—A Better Fire Control Gear for Fixed Machine Guns on Airplanes

The forward machine gun on an airplane is fixed and fires between the propeller blades in the direction in which the machine is headed at the time of firing.*

The function of a fire control gear is to control the fire of an aircraft machine gun shooting through the propeller so that no shots will be fired when the blades of the propeller are in a position where they are in danger of being struck. This is done usually by a cam attached to the crank-shaft or geared to the propeller which sends an impulse by mechanical or hydraulic means to the trigger mechanism of the gun only when the propeller is in a safe position for the gun to be fired. This impulse trips the trigger and a shot is fired. As gears are now designed, two impulses are given to the gun every time a blade of the propeller is in a certain position with reference to the bore of the gun.

Fire control gears are of two types: hydraulic and mechanical. The advantages and disadvantages of each type are listed below.

HYDRAULIC GEAR. Advantages: Allows gun to be placed in any position with reference to the engine, inasmuch as the hydraulic pipe line can be bent.

Disadvantages: Difficult to fill and take care of. Requires a good deal of special training and experience to get good results. Many small parts to get out of adjustment. Difficulty from leaking.

Lag in impulse due to time taken by hydraulic wave to pass down pipe line. This causes a wide dispersion of shots for changes in the R.P.M. of the propeller. Shots fired at low R.P.M. fall too near one blade of the propeller and shots fired at high R.P.M. too near the other blade; thus the safety margin is cut down and R.P.M. the gun may safely be fired at is limited.

At low R.P.M. the impulse changes from a pressure wave to a simple hydraulic action and the gear cannot then be depended on.

MECHANICAL GEAR. Advantages: Action always positive and certain. No lag of impulse in transmission. Easily taken care of and adjusted.

Disadvantages: Position of gun limited with reference to the engine as it is difficult to send impulses around corner. In case where impulse is transmitted by rods difficulty is encountered from whip. Wear in rods and cams affects timing.

Disadvantages of both types of gears:

In both types of gears the principal drawback is the dispersion of shots between zero speed and maximum speed which limits the type of propeller used and limits the safe firing speeds. This is greatest on hydraulic gears.

Rate of fire of gun dependent on R.P.M. of propeller. For example, if a machine gun is designed to shoot 800 shots per minute and the propeller is turning over at 400 R.P.M., or 800 impulses are given per minute, the gun will fire on every impulse and the rate of the geared gun will be 800 shots per minute. If the propeller is turning at 500 R.P.M., or giving 1,000 impulses per minute, the gun cannot use every impulse, but will use every other impulse, and the rate of fire will only be 500 shots per minute or the efficiency will be decreased. This is an important disadvantage of the present system.

The ideal fire control gear:

(1)—Maximum rate of fire is obtained at all R.P.M. of the propeller. (2)—The time of impulse is advanced as the propeller speed increases so that shots at maximum speed will fall in the same position with reference to the blades of the propeller at the plane of the propeller, as shots at zero speed. (3)—Easily placed at any position with reference to the engine. (4)—Simple to take care of and adjust.

It is obvious that if the first advantage is obtained, the second must be sacrificed, but a better combination of the two is desired than we have at the present.

The problem which presents itself is to devise a fire control gear which incorporates the above advantages. The solution seems to lie in an electrical system.

Calculations must be based on the following data: Distance from muzzle of gun to plane of propeller varies from 3 to 6 feet. Maximum propeller speed 1,600 R.P.M. Rate of fire of airplane machine gun 1,200 shots per minute.

Problem No. VII.—Improvement in Airplane Cable Braces

The present method of attaching the ends of cables to turnbuckles and anchorages is by bending the end of a cable around a protecting liner and wrapping the overlapping end with brass wire, and then soldered.

This is an unsatisfactory, wasteful and expensive method. If some very simple method of anchoring cable ends could be devised, it will greatly speed up the production of aircraft.

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*The considerations governing airplane machine-gun fire and full descriptive test of the armament are contained in the book "Practical Aviation for Military Airmen" by Major J. Andrew White.

Aviation News

Pershing Honors Gallant Aviators

The Commander in Chief of the American Expeditionary Forces, in the name of the President, has awarded the distinguished service cross to the following officers and soldiers: First Lieut. Joseph C. Raible, Jr., 147th Aero Squadron. — For extraordinary heroism in action near Château-Thierry, on July 5. He and three other pilots, at an altitude of 4,700 meters, attacked an enemy formation of eight battleplanes flying at an altitude of 5,000 meters. Home address: J. C. Raible, 2,102 Chestnut Street, Hannibal, Mo.

First Lieut. Arthur H. Alexander, 6th Aero Squadron.—For extraordinary heroism in action on September 4. While on a bombing expedition with other planes from his squadron Lieutenant Alexander engaged in a running fight over hostile territory, with a superior number of enemy battleplanes, from Friauville to Lamorville. Home address: Mrs. Stella H. Alexander, Box 105, Wellesley, Mass.

First Lieut. Donald B. Warner, 96th Aero Squadron.—For extraordinary heroism in action on September 4. During the combat he was severely wounded, his right thigh being badly shattered. In spite of his injuries, he continued to operate his machine guns until the hostile formation had been driven off and one plane shot down burning. Home address: Mrs. C. E. Warner, 175 Humphrey Street, Swampscott, Mass.

First Lieut. Alfred A. Grant, 27th Aero Squadron. —For extraordinary heroism in action near Château-Thierry, on July 2. By skilful maneuvering and good marksmanship he destroyed one machine and drove off the other two. Home address: Alfred A. Grant, father, 86 Syracuse Street, Denton, Texas.

First Lieut. Charles W. Drew, 13th Aero Squadron. — For extraordinary heroism in action near Flirey on August 15. He operated one of a patrol of four machines which attacked four enemy battleplanes. In the fight which followed he attacked in succession three of the enemy airships, driving one of them out of the battle. He then engaged another machine at close range and received ten bullets in his own plane, one of which penetrated his radiator, while another pierced his helmet. In spite of this he followed the German plane to a low altitude within the enemy's lines and shot it down in flames. Next of kin: Mrs. S. E. Drew, 246 West Seymour Street, Philadelphia, Penn.

Second Lieut. Arthur H. Jones, 147th Aero Squadron.—For extraordinary heroism in action in the Toul sector on July 16. He and four other pilots were attacked by nine German pursuit planes. Without hesitation, he dived into the leader of the enemy formation, pouring machine-gun fire into him at 100 yards. After a quick and decisive combat, the enemy leader fell out of control. Lieutenant Jones then attacked two of the other enemy planes, which were attacking him from the rear, and succeeded in driving them off. Home address: Mrs. A. H. Jones, Haywood, Alameda County, Cal.

First Lieut. Walter L. Avery, 95th Aero Squadron. —For extraordinary heroism in action north of Château-Thierry on July 25. Home address: F. E. Avery, 1,199 Franklin Avenue, Columbus, Ohio.

First Lieut. Louis G. Bernheimer, pilot. Home address: Sidney Bernheimer, 138 72d St., New York City.

* * *

Lieutenant Alan Winslow Receives the War Cross

Lieutenant Alan Winslow of Chicago and Yale has recently been awarded the much coveted War Cross for conspicuous service while flying in France. This American airman is the son of a wealthy Chicago manufacturer and a member of the class of 1918 at Yale University. After two years of training he attracted the attention of the authorities by his fearless flying at the front.

In the air encounters just prior to the cessation of hostilities much was demanded of the antagonists. It was not sufficient for the airmen to be fearless and skilful in ordinary air maneuvers. His life depended upon his skill in performing feats in midair which a short time ago were considered merely circus stunts too perilous for any useful purpose. To out-maneuver and out-fight the Germans, the airman had to outmatch them in "looping the loop," in spinning nose dives and in all the feats of modern airmanship. Among the thousands of airmen flying at the front, Winslow distinguished himself and has been officially recognized for his skill.

Lieutenants Winslow and Campbell (the first American-trained aces) were near the front one day playing cards when the alarm was sent out that an enemy fleet of airplanes was approaching. The two airmen, running to their machines, leaped to their seats and rose to meet them. Each airman picked a Boche from the fleet and started after it.

The German was in full retreat when Winslow, using all the speed at his disposal, succeeded in overtaking his man. Seeing himself in danger, the German resorted to the desperate expedient of "looping the loop" at close quarters. The German machine succeeded in describing a circle about Winslow's machine which made it practically impossible for him to train his gun effectively, but by resorting to the same tactics Winslow finally succeeded in gaining a favorable position. When his aircraft had swung to the right angle Winslow fired with a sure aim and the German plunged down out of control.

The moment his enemy was disposed of Winslow turned and started to help Campbell, who was engaged in a lively battle in another part of the sky. Between them the other Boche was disposed of, and the rest of the fleet then retreated. The two Americans, communicating with each other by means of the radiophone had achieved their victory by cool teamwork. On landing after the battle the two Americans were the subject of an enthusiastic demonstration by the French aviators who had watched the battle from the ground.

Lieut Alan Winslow, the first American-trained ace to receive War Cross

Experimenters' World

A High-Speed Key of Unique Design

MORE amateur dreams of a high-speed sending key have been wrecked upon the rocks of mechanical difficulties that were insurmountable, than any other device that I know of. The prohibitive price of the manufactured article places it beyond the reach of the average amateur's pocketbook, and the complicated nature of the instrument prevents its successful manufacture in the average workshop.

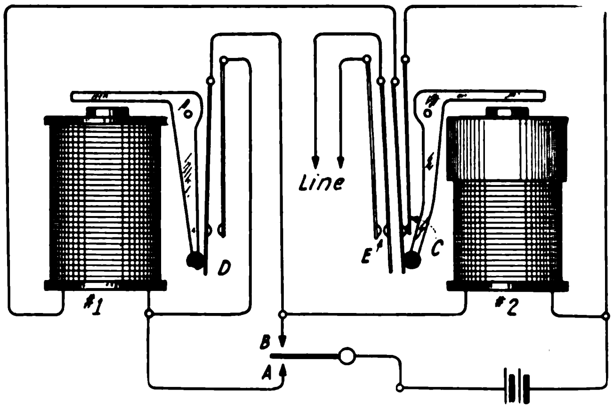


Figure 1—Showing the circuit of the high-speed key

I present herewith, however, an automatic key operating by an electrical slow acting relay instead of mechanical mechanism.

If we encircle an electromagnet with a closed copper ring of very low resistance, and if a current passing through the electromagnet is suddenly broken, there will be a secondary current induced in the copper ring which will in turn magnetize the core, thus tending to prolong the magnetic action.

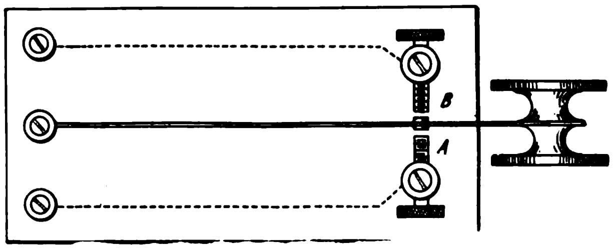


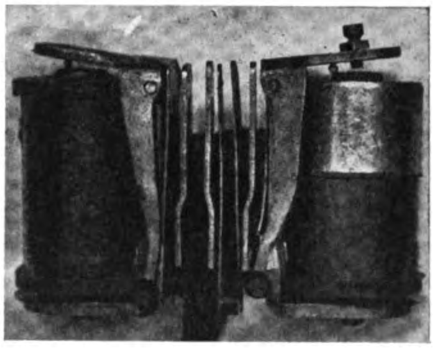
Figure 2—Simple form of the double contact key

This is precisely what is required for the electrical operation of our dot-making device in the high-speed key. In figure 1 is shown the circuit for the instrument, this consisting of a double contact key at AB, a battery and two electromagnets, number 1 being an ordinary magnet of about 20 ohms resistance, and number 2 being one of the slow-acting type just described. In order to give satisfactory results, the copper slug should be about ½" long and 1" in diameter, with a hole in the center of the diameter of the core.

The operation of the device is as follows: Closing the contact A allows the battery current to flow into coil number 1 through the contacts C. This pulls up the armature of number 1, closing contacts D, thus allowing current to flow into coil number 2, which in turn pulls up and opens contacts C, at the same time closing contacts E, which are connected to the main line. But the opening of contacts C releases coil number 1, thus opening contacts D and releasing coil number 2. This coil, however, requires an instant before releasing, which then starts the cycle over again.

The photograph shows such an arrangement as constructed by the author, using stock telephone relay parts, which was found to be entirely suitable. When sending at a speed of 20 words per minute, the speed of making dots varies from 8 to 12 per second; any variation of speed desired may be secured by adjusting the spring tension and the distance between the armatures and cores.

Figure 2 shows a simple form of double contact key to be used at AB. It consists of a steel corset stay rigidly fixed at one end, and making contact either with A for dots, or with B for dashes. Two key nobs are screwed to the other end for its manipulation, and it is operated just like the ordinary high-speed key. In using a key of this type, practice is required to get just the correct number of dots in each letter, but a few weeks are sufficient to make one fairly adept.



High-speed key apparatus constructed by using stock telephone relay parts

ARNO A. KLUGE—*Nebraska.*

A New Capacity Meter

THE objects of the apparatus herewith described are:

(1) To enable the capacity of a condenser to be very accurately and rapidly measured.

(2) To assist in the manufacture of condensers of a definite capacity.

(3) To enable variable condensers to be accurately and rapidly calibrated.

(4) It is intended as a useful instrument in the design of wireless apparatus.

The capacity meter depends for its action on the utilization of the phenomenon of "beating effects" produced by two sets of superimposed continuous oscillations. Continuous oscillations are set up in the grid and plate oscillating circuits of a vacuum tube by coupling the inductances. Another similar circuit is arranged with telephones included in the plate circuit.

If the frequency of the continuous oscillations in the first circuit A is made approximately equal to the frequency of the oscillations generated in the second valve circuit B, audible beats will be produced which will give a note in the telephones of the B circuit. The pitch of this note depends on the difference between the frequencies of the two sets of oscillations; that is, the note frequency heard is equal to the difference of frequency of the two sets of oscillations.

When the frequency of A is equal to the frequency of B, no beats will be produced, and therefore nothing will be heard in the telephones. The moment the frequency of A is altered, however minutely, by altering the inductance or capacity of its circuits, a note will be heard in the telephones of B. If the difference of frequency of the oscillations in A and B exceeds about 14,000 per second, although beats are still produced, nothing will be heard in the telephones.

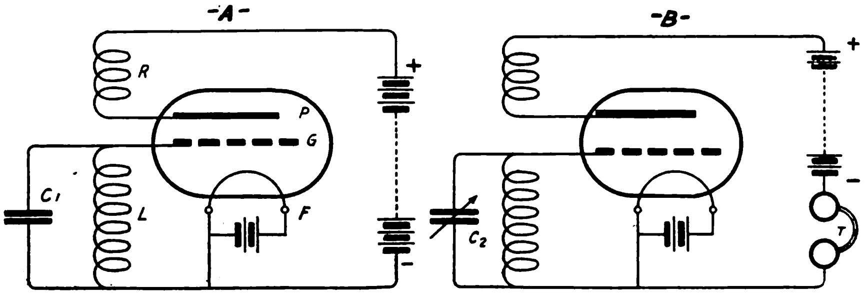


Figure 1—Diagram of two continuously oscillating circuits used in the capacity meter

The invention uses the phenomenon of the beating effects to compare the capacities of condensers. Figure 1 shows two continuously oscillating circuits A and B. These circuits might be mounted in a box. The circuit A may conveniently be oscillating at, say approximately, a frequency of 500,000 per second.

C_1 is a very accurate standard condenser of, say, .002 mfd. capacity. By varying the variable condenser C_2 the frequency of the oscillations taking place in B circuit may be altered on either side of 500,000. If the oscillations in B are of a frequency of 400,000 nothing will be heard in the telephone. As the capacity of C_2 is gradually decreased, the frequency of the oscillations in B will increase and a very high note will be heard, owing to the establishment of audible beats which are rectified by the vacuum tube. This high note will gradually become lower as the frequency of B approaches the frequency of A, namely 500,000 per second. When the frequency of B equals that of A, no beats will be produced. The graduation of .002 mfd. should be made on the condenser C_2. On still further increasing the frequency of the oscillations in B, a note will be heard again which will rise higher and higher and finally die out.

Several different standard condensers should be substituted for the condenser C_1, and in each case a graduation should be marked on the condenser C_2 when it is adjusted to such a position that a variation to either side will cause a note to be heard in the telephones. Intermediate graduations are then marked on the scale of the condenser. When the condenser C_2 has been completely graduated by means of accurate standard condensers, the instrument may be used for a variety of purposes.

To measure the capacity of a condenser of uncertain capacity, the condenser should be connected in place of the C_1 condenser of the A circuit. The condenser C_2 is varied until a "chirp" is heard in the telephones. The middle of this chirp is found so that a variation to either side would give a note in the telephones. The calibration mark of the condenser C_2 will then register the capacity of the condenser under test. This result will be exceedingly accurate. Even the alteration of capacity by placing the hand near C_1 will be indicated by hearing a note in the telephones, since the balance of frequencies has been upset.

If a condenser of, say, .0005 mfd. is to be constructed, the condenser should be made approximately of the correct size. It is connected in place of the condenser C_1. Its capacity is then measured by turning the condenser C_2 until the middle of the chirp heard is obtained. If the capacity is too high, the plates of the condenser should be reduced, and tests made until the capacity is exactly .0005 mfd.

A variable condenser may be calibrated as follows:

Connect the variable condenser in the position of C_1. Make a number of calibrations by balancing C_1 and C_2 as described, calibrating C_1 with the readings given by C_2. The accuracy is exceedingly high since the slightest difference of capacity is indicated by an alteration of the note.

The procedure for measuring the capacity of large condensers is somewhat different. When the capacity of a large condenser is to be measured, a small standard condenser would be included in the instrument and would be connected in series with a large condenser. A separate calibration chart would be provided with the condenser C_2. When measuring small capacities the standard condenser would be connected in parallel.

LIEUT. J. SCOTT TAGGART—*Great Britain.*

A Satisfactory Lead-In

THE following is a satisfactory method of bringing the aerial lead-in into the radio room where it is undesirable to drill through the window frame. A pane of glass is removed from one of the sashes and one corner is cut off; then it is replaced and a thin piece of either wood or fibre, drilled to pass a porcelain bushing, is fitted into this space in the corner of the sash. It is fastened in with brads and putty the same as the window pane. This bushing consists of two tubes placed inside of one another with pitch run in between. The wood or fibre corner should be well varnished to prevent warping. It will also be well to provide a small drip shield cut from sheet metal and soldered to the conductor near the point where it enters the bushing to prevent the beads of rain from following the lead-in into the room. Figures 1 and 2 are self-explanatory.

J. A. WEVER—*Maryland.*

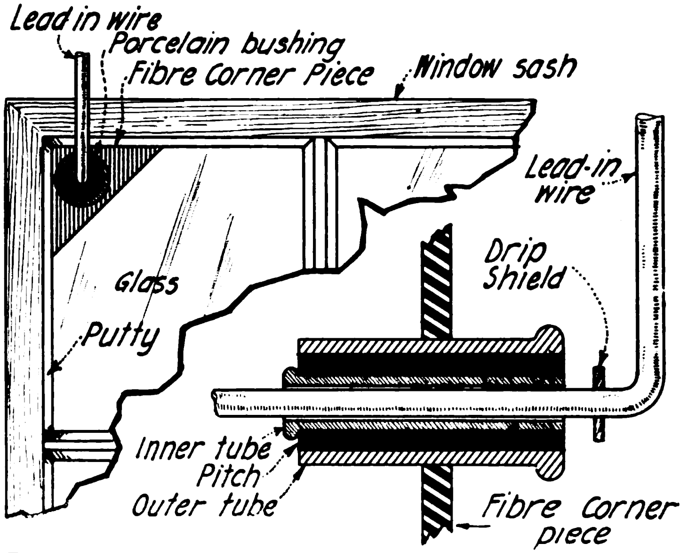


Figure 1 (upper left) and figure 2 (lower right) illustrate the construction and application of the aerial lead-in

A Unique Life Preserver

THE accompanying drawings and photographs show the use of a novel life preserver suit, which, in addition to the one wearing it, can support five others in the water. Never before in the history of the world's progress has there been such an imperative need for a life saving device that is thoroughly reliable. New dangers, added to the old, startle one daily with the toll taken of men, women, and children who travel by ship. Not alone the ocean, but coastwise waters, lakes, bays, and rivers are claiming an ever-increasing human price as boats multiply and high power and greater speed is developed, until many dread to plan a voyage or to think of loved ones and friends going on yachting cruises, motor boat trips, or even on river excursions.

High seas, cold weather, vast distances have no terrors for these men when protected by the safety-suit whose buoyancy is sufficient to support six persons in water

The safety-suit illustrated is a self-guarantee against nautical disaster and accident. It makes drowning almost impossible and protects the wearer from exposure and its after effects. It keeps the ship-wrecked traveler afloat for hours and days. It is a one-piece garment, perfect in workmanship and material, and can be put on by man, woman, or child in less than a minute.

On land again after a sojourn in the cold waters of New York Bay in November

Little has been done to insure the safety of passengers in the event of disaster, during the hours which may elapse between the sinking of a ship and the arrival of assistance. The open boat, the life raft, and the primitive life preserver are the devices to which the traveler must turn when the ship fails him. The history of marine disasters has demonstrated that the launching of boats under stress is a hazardous undertaking at best and often is made impossible by the list of a sinking ship, a rough sea, or damage to the boats themselves. The life raft, washed by every sea, is a makeshift; and the final dependence of the passenger must be placed upon the individual life preserver.

It is often asked, "Has the life preserver made good?" Experience proves that it has not. Let us suppose that you are aboard a sinking ship. A wireless call for help has been sent broadcast over the ocean, and, a hundred miles away, a steamer turns about with smoke pouring from her funnels, while her wireless crackles a message of hope. There is barely time to adjust a life preserver, gather a few of the most precious possessions and scramble up to the tilted deck, when one finds oneself afloat—submerged to the neck in icy water. Before help can be secured several hours often elapse—several hours of exposure such as no human being can live through.

In addition to keeping one afloat, it is agreed that an effective life saving device must keep the body warm and dry in water for an indefinite length of time; it must keep the body upright with head well out of water; it must be quickly adjustable and proof against accident that might render it ineffective; and it should be compact, light and easy to carry. The safety-suit illustrated is a device which answers fully all of these requirements.

It enables the wearer to remain afloat for an indefinite length of time and to emerge warm and dry, notwithstanding cold water, rough sea, and strong wind. It contains a pocket large enough to carry a canteen and liquid food to last the shipwrecked 48 hours and more. It affords abundant space in which to carry valuables or papers, with the assurance that they will remain dry and safe, whether in the pockets of one's clothing or otherwise placed within the suit. It is equipped with a shrill whistle, readily accessible, with which to help attract the attention of rescuers. It embodies every device that human ingenuity can suggest to insure safety while in the water.

The suit is made in union style, with shoes and mittens, all in one piece, completely enclosing the body, excepting the head, in a water-tight garment.

Meters for Wireless and High-Frequency Work

A HIGH-GRADE, hot-wire measuring instrument designed particularly for wireless and other high-frequency work, depending for its operation upon the expansion of a metal strip which is heated by the current to be measured has been developed by the Westinghouse Electric & Mfg. Co. The slight sag in the conducting strip is magnified several hundred times on the scale by means of a combination of wires and a deflecting spring.

Switchboard ammeter

The conducting strip is made of special non-corrosive material. The separating posts have the same temperature co-efficient of expansion as the conducting strip, so that the changes in room temperature do not cause an error in the reading of the instrument.

The flush-mounting form, known as type EH is of the round open-face type. The face is 3 inches in diameter, and the diameter outside the flange is 3¾ inches. It has a black rubberoid case and rim, with white dial.

The portable form, known as type PH, is mounted in a Morocco leather-covered wooden case with heavy glass over the dial. The case is 3¾ inches by 4⅛ inches by 2 inches thick.

The scale plate is made of metal, and the scale subtends an arc of 90 degrees, being 2⅛ inches long.

Portable ammeter

The type EH meters have a guaranteed accuracy of 2 per cent, while the type PH, with hand-marked scale, can be expected to show an accuracy within 1 per cent of full scale. Standard meters are for 1, 2 and 5 amperes. Care must be used not to subject the instrument to more than 200 per cent load.

The Monthly Service Bulletin of the NATIONAL WIRELESS ASSOCIATION

Founded to promote the best interests of radio communication among wireless amateurs in America

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A Recount of Past Performances of Amateur Stations

NEITHER the general technical public, nor even the average member of the Institute of Radio Engineers, knows what consistent long distance work was done by a number of amateurs throughout the United States, working under the double handicap of low power and short wave lengths.

During the 1916-1917 radio season the amateur field underwent some great changes, due partly to the adoption of the short wave regenerative sets, which for some reason had not up to that time come into general use.

The first amateur relay organization which pointed the way for the record breaking relays which developed throughout that season, was the American Radio Relay League. Trunk lines were organized through the larger cities of the United States for the purpose of establishing routes over which messages could be dispatched with regularity and rapidity. The main trunk line from New York City to Los Angeles, Cal., ran through Albany, N. Y., St. Marys, O., Chicago, and thence south via Nattoon, Ill., and branched to the coast either through trunk line "E": Little Rock, Ark., Dallas, Tex., Phoenix, Ariz., and Los Angeles—or trunk line "G": Jefferson City, Mo., Kansas City, Mo., Denver, Colo., and Los Angeles.

The relay station 2ZL (2LK) at New York handled some 1,300 messages during the season, most of which were messages over these lines. The Chicago 9ZN station handled 650 and 9ALM, his assistant, 425; station 6EA at Los Angeles relayed 520 messages; 99BD at Jefferson City, Mo., 300 messages; 1ZM at Hartford, Conn., 217 messages; 9EP, one of the Kansas City, Mo., stations 200 messages; 9ZK, another Kansas City station, 150 messages; station 8ASG, at Eaton, O., relayed 110, and so on down the line.

Probably the most efficient eastern station was station 2PM operated by Faraon and Grinan at New York City. On a wave of 200 meters with 450 watts input to the transmitter, 2PM repeatedly worked stations as far west as 8AEZ, 8NH, 99BD, 9ZN, 9ALM, 9XM, 9LR, 9GY, 9HQ.

Coming a little further west, station 2AGJ at Albany, N. Y., did remarkable work; using 750 watts input he worked with 9ABD, HCL, 9LR, 9ZK, 9ZN. Boats off Key West (9ZN) reported his signals audible often thirty feet from the phones.

Next 8AEZ and 8NH about share equally the honors—8AEZ at Lima, O., and 8NH at St. Marys, O., have both been reported at Phoenix, Ariz., a distance of about 1,600 miles. Few indeed are the amateurs east of the Rockies who have not heard both these stations.

Then 9ZN at Chicago, Ill., was heard quite regularly from the Atlantic Coast to the Rockies and one night worked with 7EG at Baker, Oregon. Mr. Matthews used a 1-kw. key set and at the time was working on 425 meters. The same night he was reported at 6F9 at Los Angeles, Cal.

Also 9ALM at Chicago, and 9AV at Maywood, Ill., did remarkable work.

Coming south, 9ABD at Jefferson City, Mo., probably leads. He was heard on the four boundaries of the country and worked boats off Key West. Ranking about with 9ABD, are 9LR at St. Louis, 9EP and 9ZK at Kansas City, and 9LQ at Lawrence, Kan.

9GY at Nattoon, Ill., has been heard on both the coasts. 9GY handled a very large amount of traffic from the west and southeast through 29GJ at Albany.

In Dallas, Tex., were two very efficient relay stations, SZC and 5DU. Both have been heard on all the boundaries of the country and have been responsible for the successful relaying of a large amount of traffic.

4AA at Athens, Ga., did very good long distance work on about 450 meters using very low power.

5ED at Houston, Tex., has been heard at Philadelphia and Albany, N. Y., and New York City. He was also heard at 6ZQ at Phoenix. 4CL at College Park, Ga., did very good work, working with stations far north.

Further east was the very efficient station at Denver, OZF, who was mainly responsible for the handling of transcontinental work. 9ZF often

Suggestions for the Experimenters' World

We will pay the usual prizes of $10, $5 and $3, in addition to our regular space rates, to the three contributors who send us the best manuscripts on the following subject:

AT THE FINAL CONCLUSION OF PEACE NEGOTIATIONS, WHAT DO YOU CONSIDER TO BE THE MOST IMPORTANT REASONS FOR IMMEDIATE OPENING OF AMATEUR WIRELESS STATIONS?

This subject can be treated from the viewpoint of the beneficial services which trained amateurs gave to the government during the war or from any other logical, consistent standpoint.

Another suggestion for a forthcoming issue:

WHAT RESTRICTIONS SHOULD BE IMPOSED UPON AMATEUR TRANSMITTING SETS IN RESPECT TO POWER INPUT AND WAVE LENGTH?

Limit your manuscript to 800 words.

worked 8AEZ, 8NH, 9ZN, 9ABD and is reported as working 2PM at New York one night. Another good station at Denver was 9AMT who handled quite a few messages. 6ZQ (6DM) at Phoenix, Ariz., did fine work, having worked 9ALM and 9ZN at Chicago. He has reported also hearing thirty-one stations over 1,000 miles from him.

And last, but not least, comes 6EA at Los Angeles, which worked up and down the whole state of California, who was heard at Juneau, Alaska, 9ADL, Milwaukee, Wis., Houston, Tex., Little Rock, Ark., (1,800 miles) and by the SS D. G. Scofield (WDR) 1,289 miles out of San Francisco for Hong Kong.

There are numerous other amateurs who have piled up "records" of 1,000 miles transmission. Among this number are:

1ZL, Northampton, Mass.
1ZM, Hartford, Conn.
5ZM, Mobile, Ala.
8XA, Ann Arbor, Mich.
8U1, Pittsburgh, Pa.
8UL, Lima, O.
8YO, Columbus, O.
8ZJ, Buffalo, N. Y.
8XM, Madison, Wis.
9YG, State Agricultural College, N. Dak.
9Z1, Louisville, Ill.
3RO, Danville, Va.
4D1, Winston-Salem, N. C.
5AM, Birmingham, Ala.
5AX, Shreveport, La.
5BB, Franklinton, La.

8AAK-8CS, Saginaw, Wis., and many other 8th and 9th district stations.

These records have been due usually to the fact that the oscillatory circuits of the transmitter were correctly proportioned and carefully tuned. At the receiving end some form of the Armstrong circuit, either a Paragon, Grebe or home-made regenerative set was employed.

JOHN M. CLAYTON—*Arkansas.*

Spying on Germany in the Early Days

A RECENT article in THE WIRELESS AGE stated that wireless operators on American and other ships crossing the ocean, frequently pick up orders being sent by the German Admiralty to their submarines at sea, from the Nauen Station (POZ) in Germany. many.

For about a year before our stations were closed by the Government, I would hear every evening at 6:50 P.M. here (12:00 M. in Germany) the same messages, giving instructions to all of the submarines which came to the surface at that time in order to receive the signals. Their messages were all in cipher, different from our cipher, for they consisted of numerals and letters combined.

For the time signal, in place of the "ticks" sent out by Arlington (N A A) they used letters, G. G. G. O. O. O. X. X. X., etc. Just at 12:00 M. they gave a long dash similar to Arlington.

They evidently changed their cipher every few minutes, as they would say, Groupen 26, then Groupen 28 and so on.

WM. H. SEABURY—*Brookline, Mass.*

This is the first information we have received concerning the methods employed by the Germans in sending time signals. No trans-atlantic vessel could take down the signals from Nauen unless its equipment included an undamped wave receiver of some type. With a vacuum tube regenerative beat receiver, no difficulty would be experienced in copying signals from POZ, but it must be remembered that the average vessel is not equipped with a 10,000-meter tuner.

Results Obtained by Station "CV" (Houston, Texas) Before the War

THIS article I hope will renew pleasant memories of the hours spent by amateurs in long distance working just before their stations were closed down by government order.

Of course, most every amateur believes that he was doing the best work or had the best set at that time. I, for one, obtained most excellent results at my station and many were the nights that I closed "shop" at 4:30 A.M.

My station, being located at the extreme southern point of the United States, will no doubt make the results obtained in the South most interesting to those of the East, North and West who were also engaged in the same work.

As a whole I would say the conditions are most favorable to radio communication in the South; in fact I believe better conditions do not prevail anywhere. However, other locations may be equally good, but I doubt if it can be proven that the-so-much-thought-of Pacific Coast can equal Texas for favorable radio work.

The country is flat and a good portion is covered with trees, many towering seventy-five to ninety or even one hundred feet in height. The soil is of a somewhat sandy texture and is found to be damp about three feet below the surface, most any season.

It will be interesting for those who were in amateur work before the war, to review what was done at CV and to help keep the amateur radio spirit up so that when the war is over all the "old boys" may be able to lay aside war work and again plan to establish better records. I will record some of the best amateur transmitting and reception records together with a list of the stations heard during the period between January, 1917, and the date when my station was closed.

My very best working record made was by communicating directly with 9XN (University of North Dakota, Grand Forks, N. D.). This is a distance of 1,315 miles, air-line, and this station was worked twice within one week. No difficulty was experienced in holding conversations. On one occasion I worked both ways above five times. I hardly believe the operator in charge was aware he was working a station on the Gulf of Mexico, but if he reads this he will realize the fact. As I was not using a government call, his first inquiry after answering my call was Q R A (what station is that)? I answered back "Houston, Texas." He replied "only Houston, give me your address OM." I told him he was working with an amateur in Houston, Texas, and would give him my name if he cared for it. He would not believe this and finally quit, with the impression that someone was kidding him.

Other places where my signals have been heard are Albany, N. Y., 1,540 miles—a record distance. Superior Wis., Los Angeles and other southern places of California, Jacksonville, Fla., and Tampico, Mexico, were worked.

In amateur reception four different stations were heard that were over 1,600 miles distant (all of Northern California), and three of the four, namely, 6BY, 6KU and 6FG were heard a number of times, sometimes every night for a few nights and then only at intervals.

The amateurs of California were heard best from about 11.30 P. M. until about 3.30 A. M. There invariably seemed to be a marked "peak" in the strength of the signals from the California amateurs between 11.20 and 11.50 P. M., and again between 2.25 A. M. and 3.30 A. M.

One other thing was noted: the stations of the 6th district (California) were often heard at their twilight hours, but owing to the hubbub of Q R M it was never possible to listen to a given signal for any length of time, as someone invariably jammed it.

During the entire season five amateurs of Los Angeles were heard, some

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of them were heard with regularity, others just occasionally. 2AGT of Albany, N. Y., was heard twice during the season, but strange to state no other station of the second district was heard, and none of the first and none of the third.

At various times testing was carried on with other amateurs 600 to 900 miles distant, and interesting observations were made. For example, I was able to transmit 880 miles (9PI Indianapolis, Ind.) using but 106 watts input, or roughly speaking, 1/10 kw. power. On high power my input was 445 watts and on low power (used for local work) the transformer drew 106 watts. I was not the only one who could pull stunts like that, as I could hear 9ABD (Jefferson City, Mo., 650 miles distant) on his low power. I don't know his exact power consumption. Also I could hear 9PI when on his lowest power, as well as 9GY of Mattoon, Ill.

In receiving work, various apparatus was used at different times, but a regenerative hook-up, using a small sized home-made coupler that would tune to about 500 meters, with a variable condenser in series with the primary circuit, gave the best results. All connections were soldered, even the connections to the telephones, condensers, etc. This alone increased the signals. In the transmitting set all connections were soldered wherever possible and all conductors were of low resistance and sufficiently large to insure proper conductivity. The transformer used for this work was oil immersed and home-made, but of good construction and drawing 445 watts on *high power*.

The antenna mast was 76 feet high and constructed of 4 x 4's and 2 x 4's, and well guyed. The other end of the antenna was supported by a tree about 60 feet in height. The antenna was 90 feet long and consisted of seven No. 8 copper wires, with lead-in taken at the high end. The insulators used were 16 inches long and one inch in diameter, of hard rubber.

Queries Answered

Answers will be given in this department to questions of subscribers, covering the full range of wireless subjects, but only those which relate to the technical phases of the art and which are of general interest to readers will be published here. The subscriber's name and address must be given in all letters and only one side of the paper written on; where diagrams are necessary they must be on a separate sheet and drawn with India ink. Not more than five questions of one reader can be answered in the same issue. To receive attention these rules must be rigidly observed.

Positively no Questions Answered by Mail.

R. M., Findlay, Ohio:

About one-half ampere of antenna current is all you may expect from the spark transmitter mentioned in your first query. Keep in mind that during the period of the war, amateurs cannot construct or experiment with wireless apparatus.

Regarding your query No. 2: The insulation of ordinary wood is sufficient for receiving aerials, but not feasible for transmitting apparatus on account of the high voltages involved.

In respect to the purchase of dead-end switches: We know of no manufacturer that can supply you with these switches for the time being, but they can be quite readily constructed.

* * *

A. T. H., Albert Lea, Minn.:

We have no information regarding the possibility of the reopening of amateur wireless stations after the close of the present war. As we have stated time and time again in these columns, amateurs cannot construct or experiment with radio apparatus during this period.

Regarding your third and fourth queries: We know of no manufacturer that will supply you with end turn switches for receiving tuners.

In reply to your fifth query: It makes no difference how the coupling is varied between primary and secondary circuits of the receiving tuner. Any feasible mechanical construction can be employed.

* * *

H. H., Atlantic City, N. J.:

Any of the text-books on radio telegraphy issued by the Wireless Press will show you how to connect a stopping condenser in a receiving circuit. In the usual receiving circuit, a crystal detector and a head telephone are connected in series, and in shunt to the terminals of the secondary condenser. In this case the stopping condenser is in reality a telephone condenser being placed in shunt, in order to obtain an accumulative effect of the rectified current.

On the other hand, in the old carborundum hook-up, as shown in figure 153-A of "Practical Wireless Telegraphy," it is necessary to insert a condenser in series with the crystal detector to prevent the battery being short-circuited by the secondary windings of the receiving transformer. This condenser is of fixed capacity. On the other hand, the diagram in figure 153-B of "Practical Wireless Telegraphy," when used in connection with the crystaloi detector, gives satisfactory results only by providing a telephone condenser of very large capacity. There is nothing unusual about the construction of this condenser. It may either be adjustable by steps or continuously variable. It can be made of a number of interleaved sheets of tin foil separated by paraffine paper. By the use of a multi-point switch, taps can be taken so as to vary its capacity.

The most effective results are obtained from dry batteries for the operation of a spark coil when a series parallel connection is employed. Connect up enough series cells to provide the requisite voltage for operation of the induction coil. Then make up another group with the same voltage as the first and connect them in parallel with the first group. This connection will tend to prolong the life of the batteries.

No advantage is derived in the use of a rotary gap in connection with the spark coil, for the note of the spark discharge is already governed by the frequency of the interrupter. The only advantage that could possibly be derived from a rotary gap would be to mount it on the shaft of a mechanical interrupter and operate it in synchrony therewith. Such a method has already been described in an issue of THE WIRELESS AGE.

It would be well for you to keep in mind that amateurs are not permitted to experiment with or construct wireless apparatus during the period of the war. They will open themselves to suspicion by so doing and are subject to a penalty for any violation of the President's executive order.

* * *

G. E. W., San Francisco, Cal.:

We are unable to give you a satisfactory explanation to account for the burning out of your high voltage transformer. It may be that one of the secondary coils was too close to the iron case and, in consequence, an arc was set up on account of the difference of potential between the frame and the windings. If we were on the ground and could make an examination of the general conditions surrounding your apparatus, we would be able to give a satisfactory explanation. However, the inspector in your home port will solve your problems for you.

The burning of the collector rings on the generator probably is due to the fact that the rings are bent so that the brushes arc as the collector rings rotate.

* * *

A. B. D., Boston, Mass.:

The grid and plate circuits of a cascade vacuum tube amplifying system can be coupled through a resistance, an inductance or condenser. Satisfactory circuits have been evolved for all three methods of coupling. The plate circuit resistance for coupling is usually of the order of 20,000 ohms, more or less, depending upon the resistance of the vacuum tube.

A. F. S., Radio School, Harvard University:

You will find on page 198 of the book, "Radio Instruments and Measurements," issued by the Bureau of Standards, a decrement scale which can be trimmed off and applied to any variable condenser with semi-circular plates, which is an element of a wave meter circuit.

In contrast to the simple variable condenser whose capacity increases linearly with the rotation in the movable plates, the condenser in the Kolster decremeter is designed so that the per cent. change of capacity is the same throughout the entire range of the condenser and equal angular rotations on any part of the scale correspond to the same decrement. This is obtained from special design of the moving plates.

In the Kolster decremeter, the decrement scale is geared to the movable plates of the variable condenser. The decrement is measured as follows: The wave meter is first tuned to resonance by observing the maximum reading of the ammeter. Then the capacity of the wave meter condenser is increased to some value above resonance where the reading of the hot-wire ammeter is one-half of that obtained at resonance. A sliding ring encircling the decrement scale is then turned so that its zero point coincides with the zero point on the decrement scale. The capacity of the wave meter condenser is then decreased to some value below resonance where the reading of the ammeter is again one-half of that obtained at resonance. The notation on the decrement scale underneath the pointer (which has now turned through a certain number of degrees) gives the combined decrement of the wave meter and that of the circuit under measurement. The decrement of the decremeter being known, it is subtracted from the reading obtained as just described.

Electrical Digest

The Improvement of Power Factor by Use of Static Condenser—A Novel Method for Illustrating Electric Phenomena—Research on Searchlights

The Improvement of Power Factor by Use of the Static Condenser

MEANS for improving the low power factor encountered in alternating current power circuits have been given more and more consideration as the use of alternating current power machinery expands. The wattless current resulting therefrom is by no means wattless when figured back to the coal pile, for in such circuits the consumption of coal is required even though no power is derived from the wattless component. War-time economy demands the adoption of devices for improving the power-factor to as near unity as possible.

The lagging phase in alternating current circuits has heretofore been corrected through the use of the so-called synchronous condenser — a machine admirably adapted to this work on power lines in which the conditions are constantly changing, but in many small installations the first cost of such a machine is prohibitive.

Extensive use has been made, of late, particularly in Europe, of the static condenser, which has proved a boon to small power installations where the character of the load is more or less constant. The principal disadvantage of the static condenser compared with the synchronous condenser, is its lack of flexibility, but it possesses several real ad-

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vantages, chief among these being its efficiency, which approximates 99 per cent. Again, its first cost is low; it occupies less space than the synchronous condenser; there is a complete absence of vibrating and rotating parts, and when once installed it requires little or no attention. The reduction of the output of generators, transformer and distributing feeders, as well as the increase in heating losses and bad voltage regulation resulting from low power factor loads, have been experienced by all central alternating current power stations.

The static condenser manufactured by the General Electric Company in the United States consists of a number of condensers mounted closely together to form a compact unit. Each condenser is composed of paper and metal foil submerged in oil and assembled in metal containers.

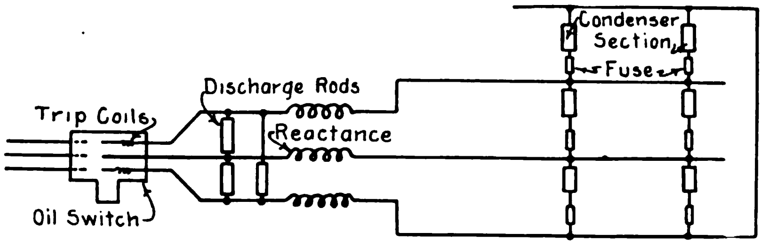

Figure 1—Schematic diagram of static condenser, showing control, discharge rods, reactance, fuse and condensers

We are indebted to a recent issue of the Electrical Review for a wiring diagram and data on the static condenser as used in typical installations. The accompanying diagram shows the three-phase installation designed by the General Electric Company.

It is pointed out that if a static condenser be connected directly across the power line, it will generally be found that instead of raising the power factor, it lowers it. This is due to the fact that a condenser tends to amplify the harmonics in the voltage wave so as to interfere with the expected increase in power factor. To overcome this and to damp out objectionable harmonics, the reactance coils shown in the diagram are connected in each phase.

The resistance or discharge rods shown in the diagram serve to discharge the condensers immediately they are disconnected from the line. As a prevention against short circuits, fuses are connected in the circuit. The trip coils controlling the circuit breaker are installed to permit disconnection of the condenser should anything occur to make it advisable for the units to clear themselves from the line.

The effect of low lagging power factors on power lines are aptly illustrated by the following example:

A 100-kva. transformer will deliver 100 kw. at unity power factor. Assuming, however, that the power factor should lag .60, then the rated energy output of the transformer would be but 60 kw. and yet the current and consequently the heating would be approximately the same as when delivering 100 kw. at unity power factor.

The ill effects of low power factor loads on alternating current generators are more striking than on transformers, for they have decreased kilowatt capacity, decreased efficiency, impaired voltage regulation and, in addition, call for increased exciter capacity. In the case of a 200-kva. dynamo designed for .08 power factor (160 kw. output), if the power factor in the circuit is but .60 it is probable that the normal voltage could be obtained only with difficulty even though at this power factor the generator would deliver but 120 kw., and beyond this the lagging or current in the armature sets up a flux which opposes the flux set up by the fields tending to demagnetize them and thereby decreasing the armature voltage. In such circuits it is often necessary to install new exciters to supply an increased exciting voltage to the field coils. The field losses and therefore the field heating are greater at lagging power factor than at unity.

The Electrical Review offers a concrete example of the effects of low power factor in a circuit. Assume that a two-mile power line is to carry a 3-phase 60-cycle load of 160 kw. at 2.300 volts; sections of 25,000 circular mils at 100 per cent. power factor, 30,820 circular mils at 90 per cent. power factor and 69,500 circular mils at 60 per cent. power factor. It is, therefore, evident that the investment in copper must necessarily be 2.8 times as great for a power factor of 60 per cent. as for a 100 per cent. power factor. Also the energy losses will be 2.8 times greater, being actually 28 per cent. instead of 10 per cent. at unity power factor. This simple problem emphasizes the necessity for a high power factor in order to attain an economical investment in materials.

Before undertaking the installation of a static condenser for increasing the power factor a complete survey of conditions should be made to determine to what extent the problem of lagging current could be remedied by it. It is desirable, for example, to locate the static condenser as near the source of the inductive load as possible in order to avoid the transmission of wattless current. It is more economical to install a number of relatively small condensers rather than a single large one. It is for this class of service that the static condenser is especially suited. Just how the size of the condenser may be determined on a given line to raise the power factor to a given value is illustrated by the following example given in the Electrical Review. Reference is made to the curve in figure 2.

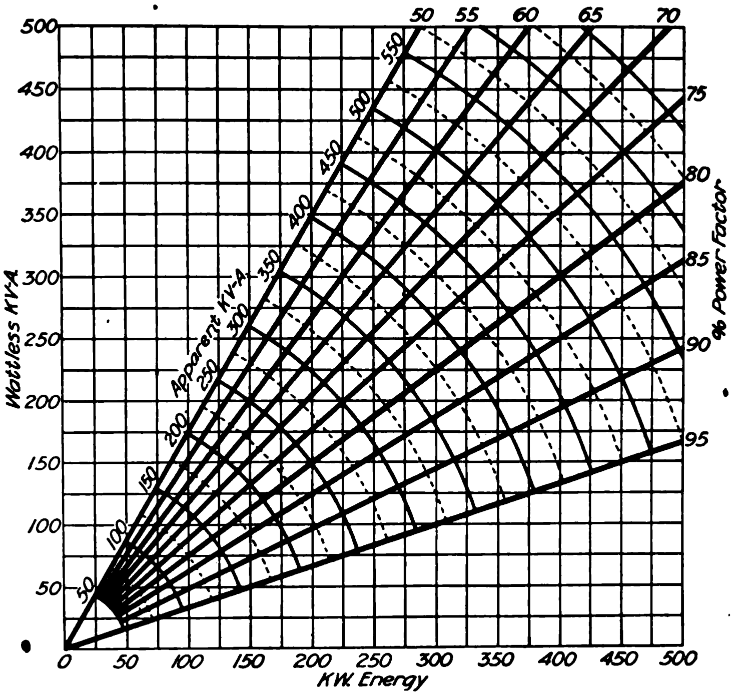

Figure 2—Curve showing relation of energy load to apparent load and wattless components at different power-factors

Assume a 250-kw. load at 0.60 power-factor, and that it is desired to raise to 0.90 power-factor.

A 250-kw. load at 0.6 is 250 ÷ 0.60 or 416 kva. apparent load which has a wattless component lagging of $\sqrt{416^2 - 250^2} = 332$ kva. A 250-kw. load at 0.90 = 250 ÷ 0.9 or 279 kva. apparent load that may be expected when the condition of 0.90 power-factor is realized. This has a wattless component lagging of $\sqrt{279^2 - 250^2} = 123$ kva. The difference 332 — 123 = 209 is the leading kva. that will be necessary to raise to 0.90 power-factor.

This may be read directly from the accompanying curve. Read up the vertical line at 250 kw. energy to the point where it crosses the 0.60 power-factor line. The apparent load may be read as 415 kva. approximately. Reading from this point to the left margin the wattless component will be found to be 330 kva. Then in the same manner the apparent load at 0.90 power-factor will be found to be 280 kva. and the wattless component read at 125 kva. The difference or 330 — 125 = 205 kva. which is close enough for all practical purposes to a 200-kva. condenser, the nearest standard size.

It will also be found in this case that using a 200-kva. static condenser will make it possible to take on an additional load at 87 kw. at 60 per cent. power-factor and still have the same total apparent load while the resulting power-factor would be 81 per cent. In other words, the possible income from the particular feeder in question may be increased 87 ÷ 250 or approximately 35 per cent.

The success with which the static condenser can be used to correct low power-factor conditions, on even most extensive distribution systems, or on shorter lines and isolated plants should appeal strongly to every central-station manager, and to those in charge of isolated plants having inductive loads. Their use may in many cases obviate the necessity for additional generator, transformer, and line capacity and will always conduce to maintenance at the highest possible efficiency the generating plant and distribution system.

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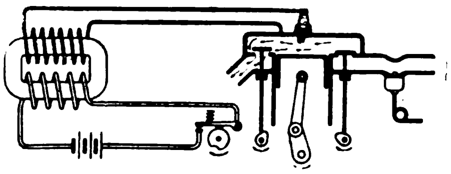

Figure 1—Ignition circuit of internal combustion engine

An example of his work is shown in the accompanying diagrams, which indicate the ignition circuit of a gas engine and the functions performed during a complete cycle.

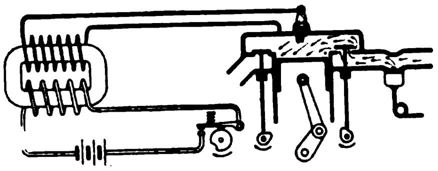

Figure 2—Circuit during intake of engine

Thus in figure 1, the engine is exhausting, the intake valve being closed. The circuit breaker of the primary of the induction coil is open. In figure 2, the engine is on the intake stroke, the exhaust valve being closed, and the circuit breaker of the induction coil is still open. In figure 3, the intake valve and exhaust valve of the engine are closed and the charge taken in on the intake stroke is now being compressed. It is to be noticed that the primary circuit of the induction coil is closed as indicated by the darkened line.

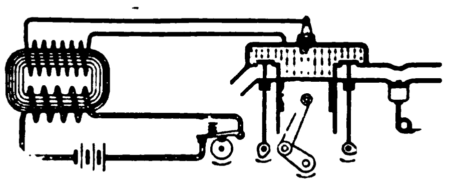

Figure 3—Battery circuit closed

In figure 4, the piston is nearing the dead center, the circuit breaker on the primary of the induction coil is open, the magnetic lines of force in the core of the coil are collapsing and the high voltage current flows through the secondary coil as shown by the darkened line. A spark is now discharging across the spark plug and a moment later complete combustion will take place in the cylinder. Afterward the cycle of operation will be repeated.

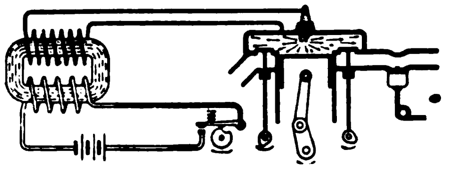

Figure 4—Secondary circuit discharged through spark plug

The diagrams should be of particular interest to aviation students.

Research on Searchlights

LABORATORIES having proper facilities to carry on extensive research with arc searchlights are urged by the Corps of Engineers, United States Army, to make investigation of the following problems and present solutions. The results of such investigations should be sent to the Officer in Charge, Searchlight Investigation, General Engineer Depot, Corps of Engineers, United States Army, Washington, D. C.

Data is desired on the following:

(a) Means for determining the finding power of a searchlight which will take into account the color of the light, the nature and color of the target, the condition of the atmosphere, and the distance between the searchlight, the target, and the observer.

(b) Means for **rapidly** determining the intrinsic brilliancy of a searchlight light source.

(c) A **simple** system of remotely controlling the operation of a searchlight in azimuth and elevation. The present or proposed systems require from five to fifteen or more wires, and are too complicated.

(d) A mirror design which shall be more efficient for anti-aircraft service than the standard parabolic mirror.

(e) A light source which shall be more efficient than a high-intensity carbon arc. A thallium arc has been suggested because it has only one line (green) in the spectrum.

(f) A mirror material which shall have the reflecting and longevity properties of silver-backed glass, without the fragility of glass mirrors.

Progress in Radio Science

(*Continued from page* 14)

separate lead 5′ sealed into the stem 6 of the device. By this construction the starting filament is located a greater distance from the anode 9 than the arcing tip of the cathode, in order to guard against the arc deserting the tip 3 and running to the starting filament either entirely or in part.

The anode 9 may have any convenient shape and may consist of refractory material such as tungsten or carbon, or volatilizable material such as mercury, as shown at 10 in figure 3. In a rectifier the anode should have a materially greater heat dissipating capacity than the cathode, to enable it to remain below a temperature of about 700° C. at the normal operating current of the device.

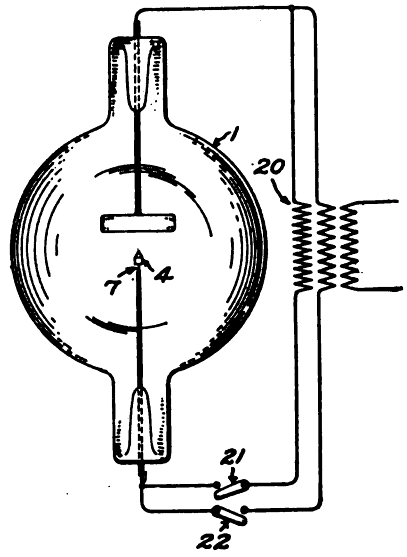

Figure 2—Modification of figure 1, with standing filament omitted and arc started by high-voltage discharge from a pointed cathode

In the preparation of the rectifying tube, the space within the envelop should be carefully exhausted of all gases and vapors, care being taken to remove electro-negative gases, such as oxygen or chlorin, or substances yielding electro negative gases, such as water vapor. A trace of oxygen does little harm when the electrodes consist of oxidizable metal, such as tungsten or molybdenum, as the oxygen combines chemically with the heated electrodes to form non-volatile oxids. The envelop is filled with a gas inert to the electrodes, as, for example, argon, nitrogen cryptom, neon, hydrogen, at a pressure which may be between several millimeters and atmospheric pressure, or more. These gases should be substantially free from electro-negative gaseous impurities. For low voltage rectifiers a gaseous pressure of 5 to 12 millimeters of mercury is desirable, but no definite limit of gas pressure can be given, as it will in general vary with the voltage upon which the device is operated and the character of the service required of the device. In some cases the gaseous filling may be constituted by the vapor of a material ordinarily a liquid; mercury for example. The envelop should be properly proportioned with respect to the energy consumed during the operation of the device to dissipate heat at a rate which will result in an operating temperature at which the vaporizable material has the desired vapor pressure.

The arc is started by heating the filament 8 to incandescence by suitable current introduced through the leads 5, 5′ by the conductors 11, 12, from a convenient source, such, for example, as the secondary 13 of a transformer 14. When the filament has been heated to incandescence, a current of suitable voltage is impressed between cathode and anode. As shown in the drawing, the device may be used to rectify alternating current supplied from the transformer secondary winding 15 through conductors 16, 17. The arc initially runs from the incandescent filament 8 to the anode and serves to heat the starting tip 3 to incandescence, both by heat conduction from the filament which is connected to the tip, and by reason of the proximity of the tip of the arc as well as the heated filament. The circuit of the starting filament may then be opened by a switch 18. The arc will continue to operate from the incandescent tip 3 to the anode, only half waves of current being conducted by the device illustrated. The rectified current may be used for any desired purpose; for instance, to charge the storage battery 19.

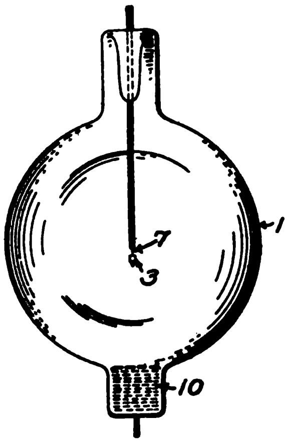

Figure 3—Tube having a mercury anode

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As the arcing tip 3 has a relatively greater mass than the filament, electrical erosion or disintegration will have but very little deleterious effect. The filament 8 is used only for a very short time when the device is started, hence the electrical disintegration of the filament is negligible. For these reasons the device will have a commercially long life.

In some cases, as shown in figure 2, the starting filament may be entirely dispensed with when the device is to be used only for relatively high voltages. In that case the arcing tip 3 is made sharp or pointed to such an extent that the arc will be certain to start from the point of the electrode as cathode when a relatively high voltage is applied to the terminals of the device; for example, by means of an auxiliary transformer winding 20. After the main cathode has been heated to incandescence, the switch 21 may be again opened and the switch 22 closed. Mr. Ferguson has found that by thus using a pointed electrode an arc may be started at a potential of about 60%, as great as the voltage required to start with a large surface as cathode. In other respects the device shown in figure 2 is the same as that already described in connection with figure 1.

A Ventilated Spark Discharge Gap

WHEN high frequency apparatus is employed in medical treatment, it is essential that spark discharge gaps be muffled for the patient's ease.

Former types of muffling proved unsatisfactory because of lack of ventilation, resulting in an irregular spark discharge and an output of gradually decreasing intensity. A discharge gap has been designed by H. G. Fischer which is substantially silent in operation and can be relied upon to maintain a predetermined operating characteristic.

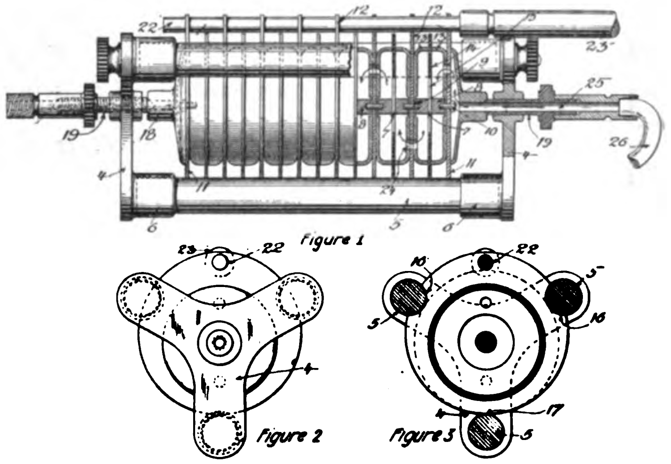


Figure 1—Showing side elevation of the Fischer spark gap with internal construction disclosed
Figure 2—End view. Figure 3—A transverse section

Figure 1 is a side elevation of the Fischer spark gap, parts being broken away to disclose the internal construction. Figure 2 is an end view of the same; and figure 3 is a section taken transversely.

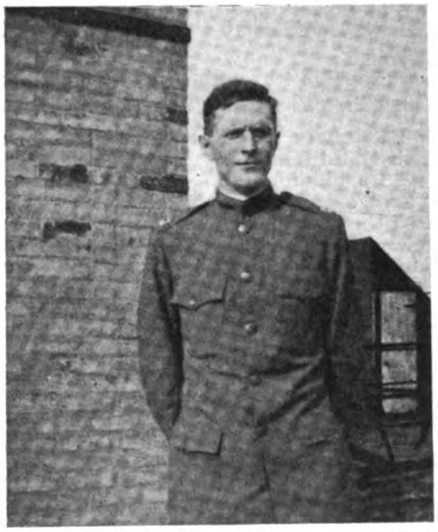
In figures 1, 2 and 3, reference characters 4 represent what may be termed end holding plates which carry three side bars 5, preferably of glass, fitting in sockets 6 appropriately arranged in the end plates 4. The spark gaps indicated at 7 occur between units 8. These units are arranged in alignment and the adjacent ones of two adjacent gaps are connected together by screws 9, the end ones being connected by screws 10 with transverse plates 11 of current conducting material. A similar plate 12 is located upon each screw 9 which connects the adjacent gap elements 8 of adjacent spark gaps. Each gap 7 is inclosed in a two-part housing 13, 13, each part 13 being fastened by screw 9 between the element and the adjacent plate 11 or 12. These housing parts 13 may also be of current conducting material. They are insulated from each other by a mica plate 14 forming a partition in the housing. Each plate 14 is provided with a restricted opening 15 about the spark gap proper. The plates 11 and 12 are recessed at two points at 16 to be engaged by appropriate glass connectors 5, and are of dimensions causing them to engage the other glass connector 5 at 17 so that the glass connectors hold them in place.

An end clamp 18 presses against each end plate 11, holding the parts tightly together through a screw post 19 in threaded engagement with an end plate or member 4. All of the plates 11 and 12 are perforated at 21 for engagement by a connecting rod 22 having an insulated handle 23, this handle permitting the rod to be pulled in and out to govern the number of spark gaps actually in operation, it being shown in figure 1 as having them all inoperative by reason of the passage of current through the rod 22 instead of across the gaps. So much of the multiple spark gap described has been tested and employed prior to this design, and it has been air confined in the housings formed by the housing parts 13, 13 that has in the past interfered with the prolonged efficient operation of the device. In accordance with Fischer's design, apertures or openings 24 are provided between succeeding housings and stagger these successive apertures with respect to each other. There is provided an opening 25 through the screw posts 19, which, in the present instance, constitute the binding posts to which connection can be made to the rest of the circuit. Air is admitted from the right, viewing figure 1, and passes along the path defined by the arrows and out at the left. In order that this action may be positive in operation, a tube 26 is provided for the introduction of compressed air continuously through the tubes. In the devices formerly in use the current has dropped within a period of, say, an hour and a half, from 700 milliamperes to approximately 200. When air has been forced through in the manner described, the efficiency has been unimpaired over a run of several hours, no variation in the current being shown.

Former Assistant Editor Wounded

ON the eve of the cessation of hostilities, word reached THE WIRELESS AGE that Captain Richard Douglas, formerly an editorial assistant, had been wounded in action. The injury is in his left foot, the heel being torn away and some doubt existing as to whether the foot can be saved.

Captain Douglas, 28 years old, secured leave of absence from editorial duties to attend the Massachusetts militia maneuvers, later entering Plattsburg with the outbreak of the war and receiving a commission as lieutenant. He was then sent to Camp Gordon and, in August, 1917, was promoted to captaincy and almost immediately embarked for overseas. Word has been received that he took part in the major engagements at Château-Thierry and St. Mihiel and was wounded during the week of October 21. As we go to press it is learned that he is in a base hospital at Baunedor.



Captain Richard Douglas, a former Wireless Age assistant editor, wounded in action

Conditions on the firing line were word-painted in characteristically broad strokes by the captain. In a recent letter he notes: "I haven't had my clothes off in ten days. I'm covered with fleas as big as grasshoppers; in more than a week the only sleep I've had has been in a sitting position in trenches filled with mud. It rains constantly. We've lived on bully beef, bread and coffee—and glad to get that—but we are going *forward!*"

A letter written a week before he was wounded depicts the bloody horrors of the war for democracy; how men were blown to pieces at his side, heads being severed from their trunks, and a battle fought in streams of blood. The war work auxiliaries come in for generous praise in this letter. Conditions which provided but two day nurses and one night nurse for some hundred-odd patients are spoken of, with the observation that these women and the head nurse "are splendid beyond praise, indefatigable, kind, gentle and cheery Ours just about fills my ideal of the holy woman of the Red Cross." This tribute to the Salvation Army is paid: "I've seen the Salvation Army girls serving rations and tending store with their masks on during a gas alarm. Coming out of the trenches, we often find them at hand with piping hot coffee and crullers."

Throughout, his letters have reflected that noble spirit of generosity which has made the American soldier so welcome and efficient abroad. As in his editorial work, Captain Douglas has recorded in military life the effectiveness of sincerity and earnest, upright effort, and THE WIRELESS AGE is proud to number him among those stalwart civilians who made material personal sacrifices to lead our troops to victory.

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Book Reviews

Practical Aviation for Military Airmen. By Major J. Andrew White. Cloth binding. 6¼x9½ inches; 208 pages. Wireless Press. Price $1.75.

Although the literature on aviation is extensive it is not exhaustive. A particular place therefore awaits Major White's textbook, for in its pages is found the first complete presentation of the varied knowledge required by the military aviator.

In fifteen chapters he has covered the subject in its entirety. The reader is first made acquainted with the theory and principles of flight and types of airplanes; this knowledge is then applied to consideration of the elements of airplane design, followed by a chapter which discusses how stability in flight is gained and how the machine is controlled. The necessary knowledge of materials, stresses and strains is then given, so the aviator may realize the importance of thoroughly assimilating the succeeding chapter which explains in detail how airplanes are erected and assembled, how controls are rigged and wires tensioned, and stabilizers and wing surfaces aligned.

Unlike most aviation books, this volume does not ignore the important subject of engines or refer the reader elsewhere for enlightenment; four chapters are given to aeronautical motors, beginning with fundamentals of motive power and continuing through study of pistons, valves and carburetors, ignition, cooling and lubrication, to types of motors, and the operation and care of engines. The subject is so clearly presented that an absolute novice may acquire within a few hours a fair knowledge of the functioning of each part of a high-powered aero engine.

Instruments and equipment for flight is the next chapter's subject, profusely illustrated with the various devices and descriptions of their use and operation. Then the practical aspects of flight are discussed, beginning with the exact manipulation of controls for simple takeoffs and landings, straightaway flights and turns. Cross-country flight and air navigation by instruments is then explained in detail and the problems of night flying carefully reviewed. Air acrobacy, upon which all fighting depends, is made clear by diagrams of the evolutions and full explanation of how the controls are manipulated to produce these amazing dips and dives, loops and turns. Meteorology has a separate chapter, this vital subject being considered in the practical applications of the science to flight conditions. Treacherous wind eddies and currents and the unfavorable conditions which are revealed by cloud formations are made known to prospective aviators and the effect of obstructions on air currents graphically described.

The two final chapters have no parallel in the literature on aviation. One discusses aerial gunnery and combat, bombs and bombing; the other deals with reconnaissance and fire spotting for artillery. Not only has the author in both cases pictured and described the armament and devices, but he has exhaustively gone into aerial tactics, anti-aircraft fire, bombing air raids, estimating enemy strength, code telegraphing, airplane radio apparatus and reconnaissance photography. The highest commendation is due for this portion of the volume, for the material here has evidently been laboriously compiled by searching investigation into actual warfare occurrences, analysis of principles and conditions affecting success in military airmanship being thereafter defined for the first time.

The volume concludes with an appendix containing conversion tables and mensuration rules, together with a nomenclature of aeronautical terms and their French equivalents, the phonetic pronunciation of the latter being given to facilitate intercourse with Allied aviators.

On the whole, the designation "Practical" in the book's title is entirely justified. The illustrations—200 or more—have been prepared with care and tell a story in themselves. The supporting text, however, will perhaps excite the principal comment. Major White has departed from usual textbook arrangement and has so prepared his material that the descriptive matter in every case is directly under or facing the illustration with which it deals. In no instance is the reader required to turn the page. This feature's value is further emphasized by the use of relative sizes and boldness of type to value the importance of each statement as it is made.

While the book is less a treatise on aeronautical engineering than a fully practical text for men who expect to fly and want to learn in the shortest possible time, the mass of data contained in the volume will insure it a place on the bookshelves of even those whose interest in aviation is purely on the theoretical side. Certain it is that this latest contribution to the literature of the aeronautic field will receive a hearty welcome wherever it goes.

Obtainable through the Book Dept., The Wireless Age.

A Dictionary of Military Terms. (Revised Edition.) By Edwin S. Farrow. Cloth binding. 5x7 inches; 682 pages. Crowell. Price $2.50 net.

Nothing is more disconcerting to the newly commissioned officer than to hear military terms in common usage which army manuals do not mention. Many an uncomfortable moment will be spared those to whom Tactical Instructor Farrow's dictionary is available for ready reference. While the compiler's primary purpose seems to have been to include the many specialized terms used in modern warfare, the work has been made sufficiently exhaustive to stand by itself as a ready reference for determining the exact meaning of both ancient and modern works on military subjects.

The value of a work of this character is perhaps best instanced by quoting a few examples from its nomenclature, words which are familiar to experienced officers but are seldom comprehended by the novice. For instance: buzzacot, dixie, revetment, logistics, indirect laying, full sap, terrain, enfilade, bracketing, chevaux-de-frise, are terms which may be heard any day about a cantonment but are likely to be meaningless to the officer from civilian life. Another glance through the volume discloses these, of which the same may be said: deflection, whippet, martinet, line of investment, kitchen police, parados, elan, allowance of quarters, aparejo, camion, barbette, ballistics, double sap, striker, ricochet, oriented—and so on. There are 12,000 definitions in the volume, a fairly large percentage of which will appear entirely new to the officers' camp graduate, yet are in daily use by officers of the regular army.

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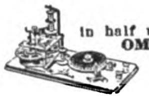

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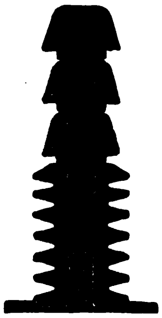
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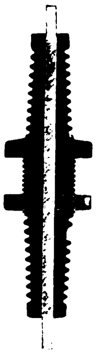
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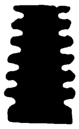
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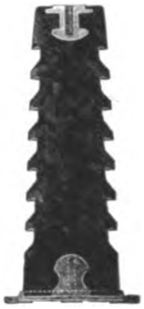
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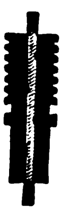
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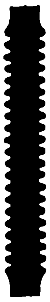
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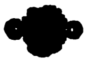
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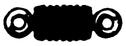
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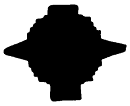
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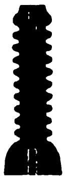
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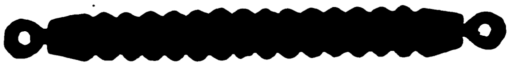
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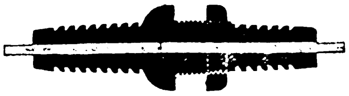
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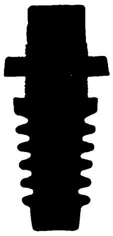
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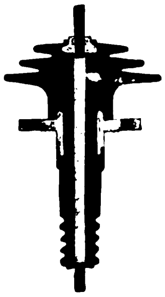
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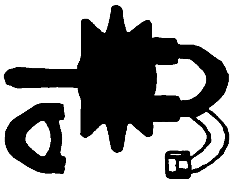
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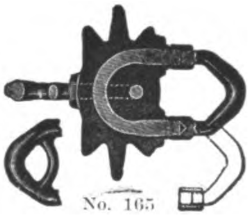
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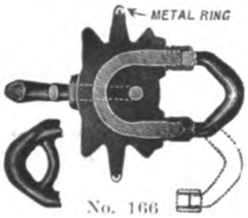

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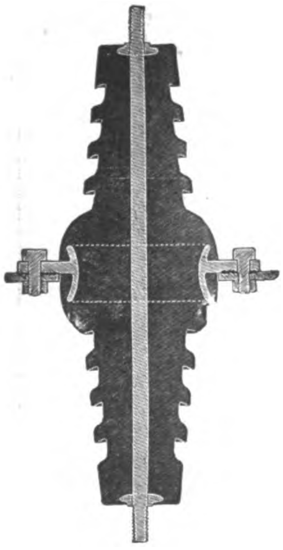
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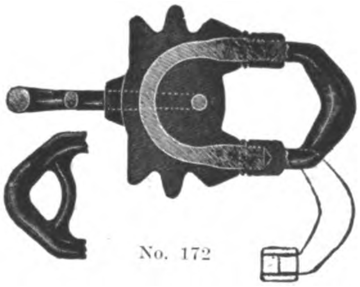
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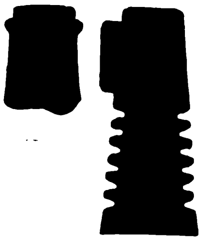
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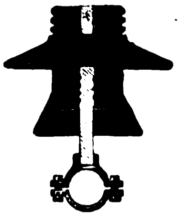
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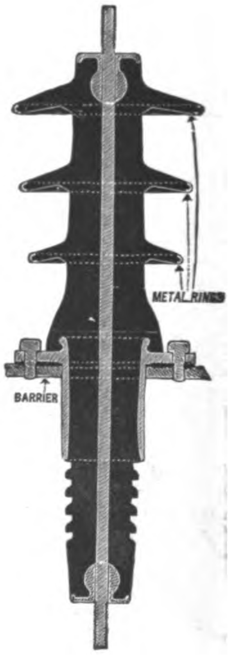

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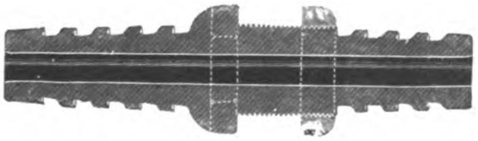
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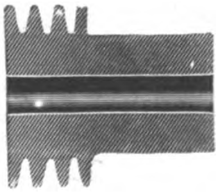
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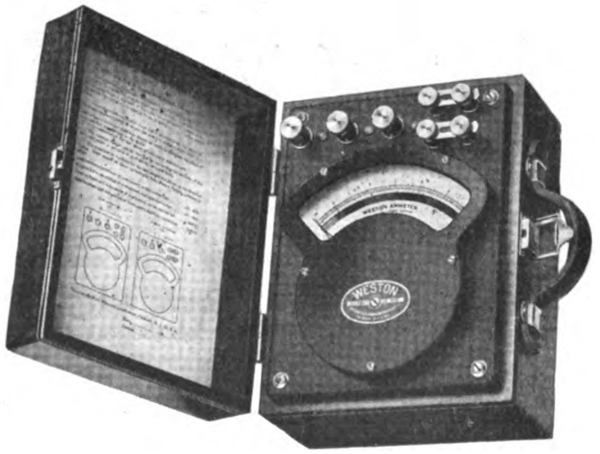

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The Wireless Age

Edited by J. ANDREW WHITE
E. E. BUCHER, Technical Editor

Vol. 6 — No. 4

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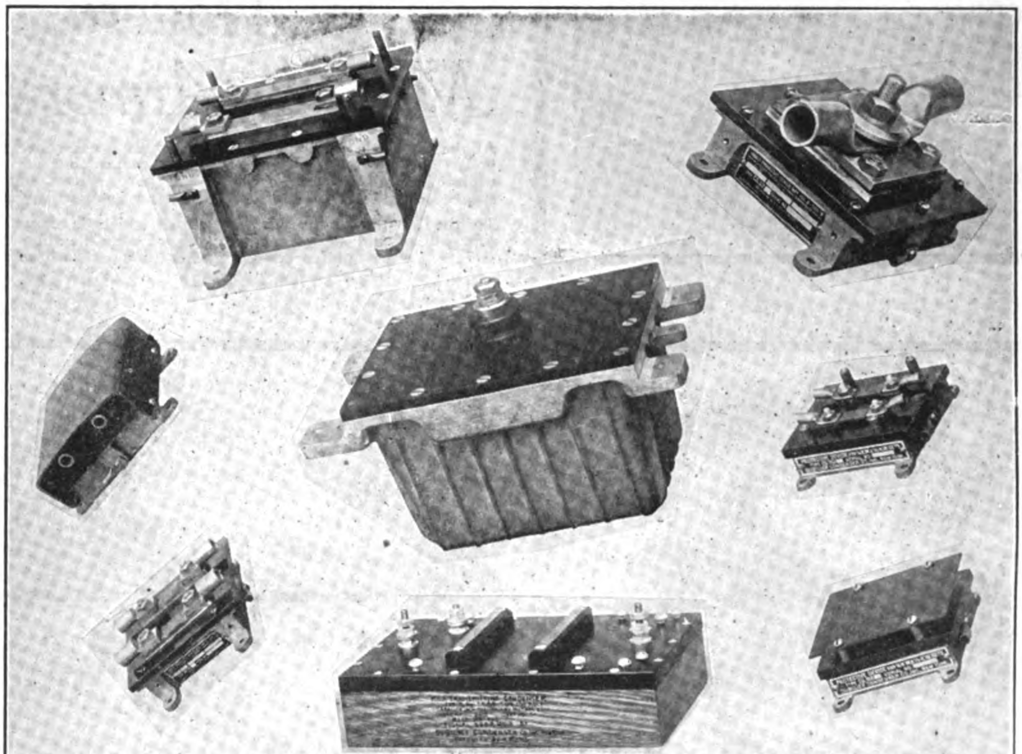

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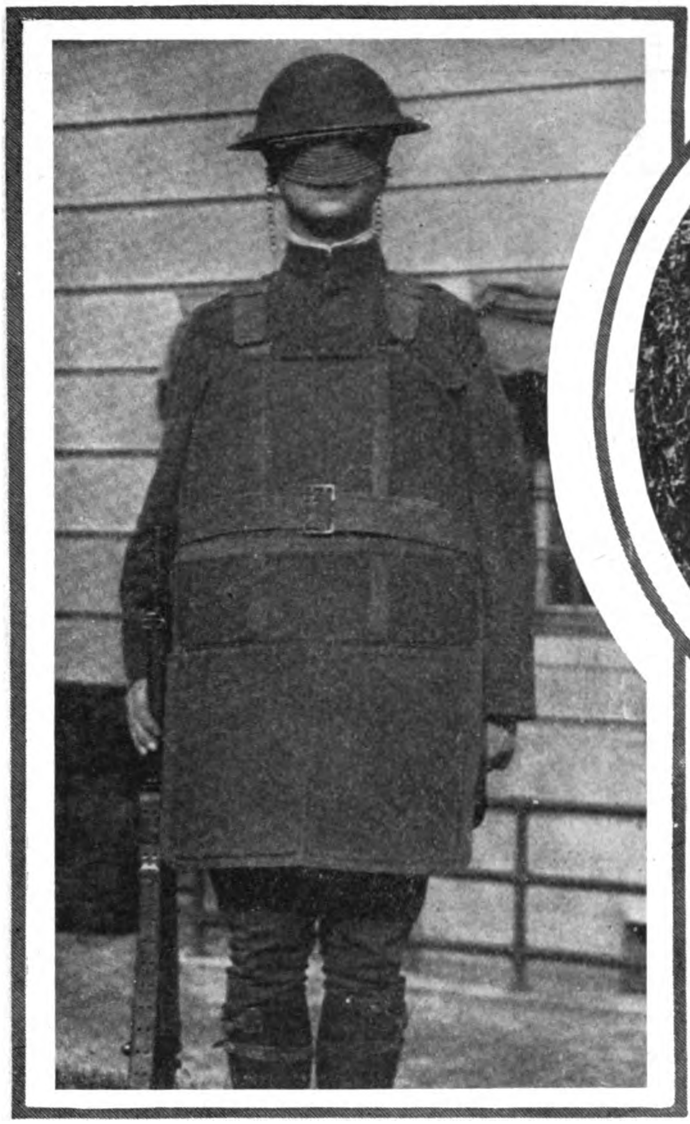

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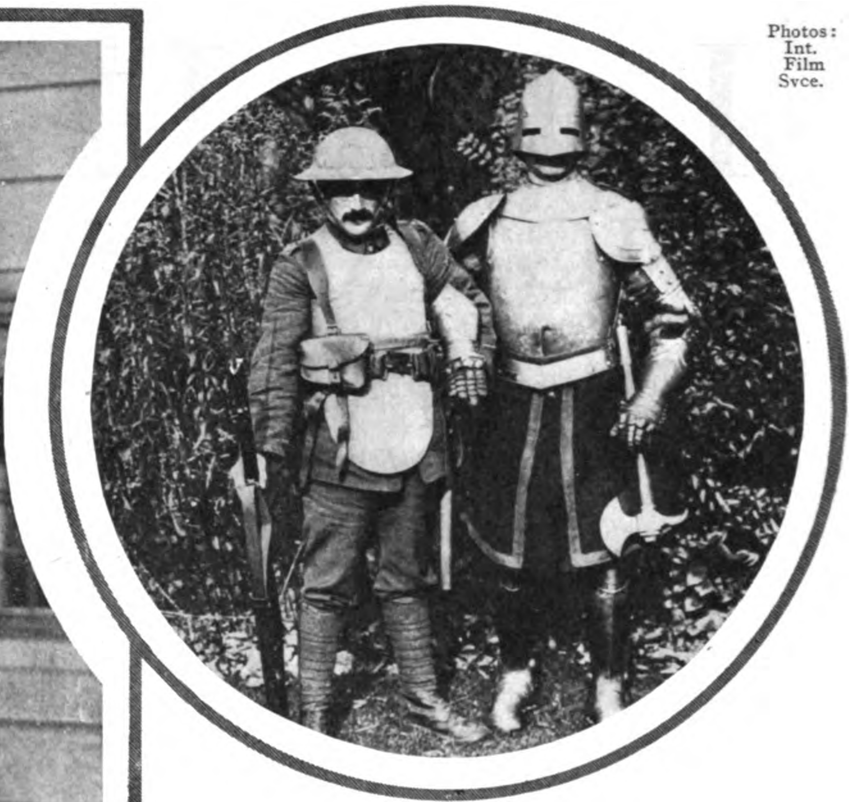

Modern Military Armor

Above, in circle, a modern fighting man's dress contrasted with ancient body armor, showing that protective metal covering has not lost its usefulness. The modern doughboy here shown has dispensed with cumbersome steel but is well protected against bayonet and shrapnel

To the left is illustrated the helmet which is capable of stopping a rifle bullet and body armor made of semi-flexible thin spring steel plates sewn together in a canvas sack

A favorite pastime in Flanders, now that the guns are silent, is trying on suits of German armor left behind by the Boche in his flight

VOL. 6. NO. 4. JANUARY, 1919

THE WIRELESS AGE

WORLD WIDE WIRELESS

Weagant's Solution of Static Problem Arouses Controversy

IMMEDIATELY following the announcement that the static problem had been solved by an invention of Roy A. Weagant, reported in the December issue, Newcomb Carlton, president of the Western Union ridiculed the idea, stating that such delusions had been coming up ever since Wireless was discovered.

Mr. E. J. Nally, Vice President and General Manager, Marconi Wireless Telegraph Company of America, being asked for further comment upon President Carlton's statement, said that while he deplored public controversy it was being forced upon him by the animus of the Western Union, adding "science and progress have ever met with the disdain of those who like to follow the lines of least resistance. These non-progressives may be divided into classes. There is the man who says it can't be done, the man who fears it might be done and the man who would like to say it shall not be done. Mr. Carlton is entitled to the distinction of adding another class for himself, in that he, claiming cryptic knowledge of something he has not seen and could not know anything about, empirically condemns it.

"It is not a nice position for the head of a large corporation to take, but he is following historically in the footsteps of some other Western Union presidents, one of whom deflected the genius of Elisha Gray from developing the telephone. Another president of similar 'low visibility' completely failed to encourage the genius of Edison, who was forced to work elsewhere than in the telegraph business, and whose wonderful achievements since are known to all mankind.

"But all of this perhaps accounts for the lack of progress of the science in land line telegraphy, which has advanced very little beyond the days of Morse, and certainly not at all beyond the days of Edison's connection with it. Mr. Carlton's statement that the claim for continuous transatlantic communication through the operation of the Weagant invention is 'humbug' is utterly false. For this is the very thing that has been established beyond a peradventure."

Michael I. Pupin, professor of electro-mechanics at Columbia University, also issued an opposition statement:

"The removal of static interference," said Professor Pupin, "is the great problem of wireless. It may never be discovered. An invention of such tremendous importance should not be announced until it has been tested by disinterested experts.

"There are already a dozen inventions that will remove static under certain conditions. What we want is an invention that will remove static under all conditions. We want to be able to send wireless messages in spite of everything excepting lightning and the will of God."

Professor Pupin, who is inventor of the Pupin coil, explained that he had demonstrated his own inventions before a group of scientists before he made them public.

Complete tests of the invention of Roy A. Weagant, which, it is asserted, eliminated static interference in wireless telegraphy, will be made next Summer, Mr. Weagant immediately announced.

"We are going to make the tests that Professor Pupin calls for during next June, July, and August," Mr. Weagant said. "They cannot be made immediately because nobody would accept tests made in Winter, when there is much less static electricity to contend with than in Summer. I cannot say yet where the tests will be made, but they will be carried out in the presence of disinterested scientists. In all probability Professor Pupin himself will be invited to attend."

"The skepticism was quite natural," he said. "It sounds big to make the announcement that we have perfected wireless after all these years, but I know we are safe. I would like to tell the whole story, but I am restrained until the peace pact is signed. I don't expect people, including scientific men, to believe it until they use it. It is like flying—people would not believe it could be done until they actually saw it done."

President Constantly in Touch with Land on Overseas Trip

SPECIAL arrangements never before used were made for handling President Wilson's wireless messages and to keep him in constant touch with Washington.

This announcement was made by Secretary of the Navy Daniels in connection with a statement that the Navy Department had been in continuous communication with the George Washington and the flagship Pennsylvania since they sailed from New York. He said:

The George Washington and the battleship Pennsylvania are both equipped with the most modern radio apparatus, some of which was installed for this particular trip.

This apparatus includes, on the Pennsylvania, the most powerful transmitting set on any United States naval ship and also special receiving apparatus for receiving from high power stations used ordinarily only for transatlantic messages. The George Washington was also especially equipped with similar receiving apparatus. On board both ships were installed radio telephones and the newest type of low power radio sets, for use only in communicating from ship to ship.

All messages for the President were sent by the new naval high power station at Annapolis, which is five times as powerful as the Arlington station. These messages were received by the George Washington and the Pennsylvania simultaneously. All replies were forwarded from the George Washington to the Pennsylvania and relayed to shore by the Pennsylvania.

At three special naval radio receiving stations, one in Maine, one in New Jersey and one in the Navy Building, Washington, expert operators listened continuously for the Pennsylvania's messages. The messages when received were forwarded with utmost despatch to the transatlantic radio division of the office of the Director of Naval Communications in the Navy Department, and the three copies compared to insure accuracy. All outgoing messages passed through the same office in Washington.

As the Presidential party approached Europe, by arrangement of the Navy Department, special receiving stations in both England and France listened for messages from the Pennsylvania, and one of the French high power stations forwarded messages direct to the ship. The President was thus kept in touch with Washington and Paris or London simultaneously.

Interior of the wireless room on the S. S. George Washington—By means of this apparatus the President was kept informed of the world's doings during his trip to France

N. Y. State Troopers Get Wireless

MEMBERS of the State Constabulary operating in New York City's suburbs, it was announced on November 23, are to be equipped with wireless telegraphy as a means of communication.

The Naval Intelligence Department informed Lieut. John Walton of the troopers that the powerful apparatus with a 5,000-mile radius, which Corporal Daniel Faber of Highland Falls station recently seized from Glen Vanvalkenberg at his home in Westkill and confiscated, is to be presented to the troopers. This is in recognition of the services they have, rendered the Navy Department in finding and confiscating many wireless stations during the war. Lieut. Walton will have the apparatus transferred to White Plains and set up there so the police can send and receive messages.

Report That Ex-Kaiser Has Station

WILHELM is reported to be closely in touch with Germany from his Holland domicile. One dispatch from Amsterdam today reported that a wireless station has been installed at the Van Bentinck castle and that German airmen flying over Maarn drop messages for him.

Marconi to Sell and Lease Ship Equipment

EDWARD J. NALLY, Vice President and General Manager, Marconi Wireless Telegraph Company of America, on his return from Washington, where he went for conference with the Navy Department, has made known a change in the policy of the Marconi Company under which it will in future sell as well as lease wireless apparatus. The first result of this change in policy has been the sale to the Government of the apparatus on some three hundred ships now under Government control and all of the small coast stations which the Marconi Company has maintained in the past but which it no longer needs under its new policy.

Mr. Nally stated that the terms of the sale were based upon the earning value of the stations and the apparatus, and added that the Secretary of the Navy had dealt with this question with the utmost fairness and with just consideration of the rights of the company's stockholders.

This transfer does not in any way affect the status of the company's large stations for transoceanic communication, but it is believed that it will have met every need of the Government for the control of domestic wireless and that there will now be no occasion for the Government seeking to secure control or ownership of the large high power stations which were built with the principal object of rendering to the public international transoceanic wireless service in competition with the cables, which is by far the most important part of the Marconi Company's activities.

Progress Announced for Japan's Radiophone

AN exchange to connect wireless and wire telephones is to be established in Kobe, Japan, before the first of the year by the Government Department of Communications, it is reported. A wireless tower 180 feet high is now being erected in front of the largest of the Kobe telephone exchanges. Wireless telephone messages from vessels within 100 miles of the South Japan port will be connected by central operators with the telephones of subscribers in Kobe, Osake, Kyoto and neighboring cities, thus serving the most densely populated section in Japan.

Police Radio Saves Lives and Dollars

ACTING police commissioner, of New York, received on December 5 a report on the work done by the wireless telegraph branch of the police department during the past two years. The wireless tower is on the roof of the police headquarters building, and the seagoing end of the service is aboard the police boat, Patrol, which covers the harbor.

The report shows that merchandise valued at upwards of $400,000 and some twenty-five lives have been saved mainly through information received by wireless. About 2,000 messages have been handled by the service. Headquarters has been able to receive messages from a distance of 1,500 miles, and to transmit them 300. On the Patrol are two operators, John Ward and Russell McKee, both patrolmen, and stationed at headquarters are Charles Goul, John E. Hanley, and William J. Ferrick, also patrolmen.

Marconi Company Opposed to Government Ownership

THAT the Marconi Wireless Telegraphy Company of America is unalterably opposed to Government ownership and operation of the radio stations in the United States which it owns, and which have been under Government control and operation since before this country entered the war, was indicated by a statement issued by Edward J. Nally, Vice-President and General Manager of the company. The statement follows:

The Marconi Wireless Telegraph Company of America, through its Vice-President and General Manager, Edward J. Nally, makes further answer today to the questions raised by the bill which has been introduced by Representative Alexander, Chairman of the Merchant Marine Committee, which seeks to give permanent government ownership of all radio communication through the acquisition and operation by the Navy Department of all wireless stations in the United States used for commercial purposes.

"Mr. Nally wished to particularly point out that the situation with respect to wireless was in no way different from that of communication by telegraph, telephone, and submarine cables. In other words, there is no special reason for Government ownership and operation of radio communication that does not equally apply to other means of communication.

"The fact that the statement prepared by the Navy Department and given out by Judge (Representative) Alexander states that transoceanic radio telegraphy is not a serious competitor of the cables, and that high-power stations are not yet able to receive from one another all day and in all seasons, proves that the Government is not able to make the most of its opportunities and get the best results from transoceanic wireless operation. This statement is a weak attempt to minimize, in the eyes of the public, the importance of wireless competition with the cables.

"As a matter of fact, before the war, the Marconi Wireless Telegraph Company had inaugurated its transpacific service with Japan and was building up a very successful commercial business with the Orient. The cable companies recognized that there was a competitor in the field, because they were forced to reduce their rates and to add new classes of service, which, during all the years they monopolized transpacific communication, they had refused to do.

"The Marconi Company, by reason of its organization and its improved apparatus, particularly with the aid of the Weagant invention, of which wide announcement was recently made, is in position to guarantee to the business public accurate and reliable service at all times and at rates lower than those charged by the cables. Already it is being petitioned by business firms on the Pacific Coast and in New York to resume its service, owing to the congested condition of the cables and the poor service which they are giving.

"It seems a pity, at this time, when transoceanic communication is so important, that commercial wireless companies should not be given the fullest opportunity to meet the public demands."

By way of answer to that part of the statement made public by Representative Alexander as Chairman of the House Merchant Marine Committee, that, except in very special circumstances, wireless telegraph companies have never made any profit, except by the sale of stock, the Marconi Company pointed to the financial showing it made for the years 1914 to 1917, inclusive. The figures, taken from the annual report for the year ended December 31, 1917, show:

Net income for year 1914, after charging reserves, carried to balance sheet, $149,877.47; for 1915, $177,316.51; for 1916, $259,888.80, and for 1917, $617,772.69.

The company has issued and outstanding $10,000,000 of common stock. Since its organization, in 1899, it has paid two dividends, one of 2 per cent. in 1914, and one of 5 per cent. in 1917.

Wireless Beats the Dutch

SOMETIME during the war British naval officers were searching the mail bags of a Dutch liner bound for New York and extracted therefrom about $200,000 in American railroad bonds. In spite of the angry arguments of the purser that the bonds belonged to the Dutch bankers whose names appeared on the envelopes the North Sea skippers took them aboard the cruiser and from thence they found a resting place in the British treasury.

Not long afterwards a delegation of lawyers representing the Dutch and American interests visited the British Embassy and laid the case before a representative of Great Britain.

He listened politely and said: "Gentlemen, you apparently have a good case, but wait a moment." With this he asked the clerk to bring in file No.—.

Taking a few slips of paper from the file he read to the lawyers not only the names of the German bankers who had sold the bonds through Dutch banks but the names of the American bankers who were actually to receive said bonds, and also all the wireless messages in regard to the transaction which had been carefully decoded by the British Admiralty experts.

The astonished lawyers politely withdrew.

Morris for George Matthew Adams Service

Another war decoration

Sayville Bought by U. S. Is Report

IT was semi-officially announced here on November 26 that the Government had bought the Sayville Wireless Station outright after it was taken over.

The station was owned by a so-called "American syndicate," and the question had arisen whether it will revert to its original private owners.

Boys Congratulated on Rounding Up Spy Stations

A TELEGRAM from Secretary of the Navy Daniels was received by the Boy Scouts of America November 15. It characterized them as "chivalric young crusaders" because of their work during the war. It also disclosed that the Scouts, working on behalf of the Government, had discovered hundreds of illegal wireless plants.

Twenty-six of these plants were found in one day. A German alien operating an underground raido station with a small New England river supplying the motive power, was taken into custody and interned. This plant was said to have been exchanging German Government messages between America and Berlin. Details of these scout activities are expected to be made public later.

Fair Californian Didn't Land Navy Job

THE latest and bravest storming of masculine citadels comes with the entrance of women into the hitherto taboo field of wireless telegraphy. The horrors of higher mathematics have been braved, the difficulties of taking twenty words a minute in the wireless code conquered, by Miss Reavis Hughes, daughter of Mrs. Walter J. Hughes, who in October completed a regular operator's course at the Polytechnic High School, Los Angeles.

But women telegraph operators are still somewhat of a novelty to United States Government officials, as Miss Hughes to her sorrow found out. After taking her regular man-sized course, passing a strenuous all-day examination with all kinds of intricate code tests and other lively matter, she emerged with flying colors and word was sent on to Washington, D. C., that Reavis Hughes was a first-grade operator. A license was sent to her, followed by a telegram notifying her of her appointment to take a special radio course for special work under the War Department, an offer which was as promptly withdrawn when it was made plain that "Reavis" was a woman and not a man. Consequently, Reavis Hughes, first-grade operator, still awaits a job, but feels certain that one soon will be forthcoming.

Britain's King Broadcasts Peace Congratulations

THE White Star liner Megantic, which arrived November 18 from Liverpool, was the first passenger vessel to be signaled from Sandy Hook since the United States entered the war. The Megantic had been used for transporting American troops overseas and will now be used for bringing back the troops to Canada.

When the news of the signing of the armistice was received by wireless late at night Captain F. E. Beadnell ordered all the decklights to be turned on for the first time since early in 1915, when the German submarines became active. All on board were roused at 7 o'clock the following morning by the continuous blowing of the siren and at 8 o'clock the flag was hoisted at the stern, while the band played "God Save the King." At noon Captain Beadnell mustered the crew and the passengers on the forward deck and read a message received by wireless from King George to the captains of all ships flying the Union Jack congratulating them for the part they had taking in assisting to win the war.

Warning Issued About Amateur Licenses

S. W. EDWARDS, United States radio inspector, with offices in the Federal building, Detroit, issues instructions to amateur wireless operators on the procedure to be followed in obtaining permission to use their equipment, warning them, also, that severe penalties may be imposed on any who attempt to use stations without proper authorization. Inspector Edwards says:

"They are advised that applications for station license may be made at once and that all such applications will be filed in the order received.

"The opening of any amateur wireless station and the beginning of amateur activities is forbidden under penalty of arrest and confiscation of all apparatus. They are informed that as soon as the ban has been lifted and all restrictions on this class of station removed, all those who make application now to this office will be individually notified by the proper government authorities. Until such a time, however, they must not use wireless apparatus in any manner or for any purpose, testing included. Should those who make application for license fail to receive any notification within a week after the treaty of peace is signed they may request further information from this office.

"After all restrictions on amateur activities have been raised and if it is the amateur's intention to use any transmitting apparatus whatever regardless of its range, they will be required to secure both an amateur station license and an operator's license for which no fee is charged. In view of the fact that such licenses held and call letters assigned before the outbreak of the war are regarded as canceled, they cannot be renewed and therefore new ones must be secured. Use of transmitting apparatus without such licenses is punishable by a fine of $500 and forfeiture of all apparatus."

Wireless Aid in Breaking Hun Morale

WIRELESS telegraphy, its conquests and achievements during the war, will be one of the alluring chapters soon to be unfolded before the public, now that the veil of secrecy imposed by the universal censorship is being removed. It will be a record of performances that will be equalled, or rather exceeded, only by the plans of development that are in prospect for the world-wide political and commercial expansion of the immediate future.

Since the outbreak of the war, and more particularly since the United States entered it, the wireless has developed a universality of uses that outrun the imagination.

Everything of international interest the President said during the war was distributed through the air. The main purpose of this distribution was to reach the people of the Central Powers, that is to say, Germany, Austria-Hungary, Turkey and Bulgaria. These methods were employed to get the viewpoint of the United States before the people of the Central Powers. First, whatever was to be sent, whether it was something spoken or written by the President, or whether it was a statement as to the number of troops that had been sent to France, was sent by wireless across the Atlantic and put into the air over all Europe.

It is assumed that the German wireless stations picked all this news out of the air and while the officials in charge of those stations did not give it newspaper publicity it did gain much publicity by being passed from mouth to mouth.

How Science Beat the Hun

The Accomplishments of the Trained Man of Science in the War *

By J. S. Ames
Professor, Johns Hopkins University

(*Continued from the December,* 1918, Wireless Age)

BOTH the army and the navy need airplanes for their operations; but after their demands are supplied, there remains the wide expanse of the air through which attacks can be made upon the enemy, far away from the battle-front and the coast. Great Britain has recognized this all-important fact, and has been building a great fleet of airplanes for this new service. In this, new instruments, new types of machines, new guns and bombs are required.

There are two main problems in connection with the submarine, first to locate it, second to destroy it. Methods of destruction are at hand in the shape of depth bombs; but methods of detection so far have not been eminently successful.

From an airplane one can see through water only to a limited depth, never more than twenty feet, and so the main reason why the seaplanes have been so successful in destroying submarines is not due to the fact that the observer in the airplane discovers his' prey, but is that his machine has such great speed, three times that of a destroyer, that when news is flashed that a vessel is being attacked by a submarine it can often reach the spot in time to drop its bomb effectively. The detection of the presence of a submarine is a definite physical problem; and it is not an exaggeration to say that at least one-fourth of the physicists of note in England, France and this country have been engaged in the attempt to solve it.

What lines of attack upon it are open? Not many.

The submarine in motion emits certain sounds; can they be heard? It is a solid body; can one obtain an echo from it? It is made of iron; can this fact help through some magnetic action?

These are the obvious lines of approach, but one should not hastily conclude that there are not others.

Without stating, and I may not, how far successful these efforts of the physicists have been, I may note that the method which is now being tested by our Navy is one elaborated by a distinguished professor of mathematical physics.

In the course of these extremely numerous experiments upon the submarine question several beautiful methods have been developed which in the future will have great scientific importance; one of these, due to a French physicist, is one of the most interesting developments in physics made within a decade.

Another submarine problem, which is by no means of secondary importance, is to develop a method by which one submarine may communicate with another or with the shore. I do not think I am saying too much when I state that this has been solved, even for considerable distances.

I cannot leave the subject of the airplane and the observation balloon without referring to the question of maps and map-making, in connection with which the former are so important.

Until one has been at the headquarters of an army, it is not possible to realize the extent to which maps are used, or the various types of maps required. There are maps showing roads, paths and trenches; maps for staff officers, for regimental commanders, for company captains, for sergeants; there are maps showing the position of the enemy's ammunition dumps, aerodromes, signal stations, anti-aircraft guns; there are maps showing the location of the enemy's batteries; there are special maps for the use of the quartermaster, etc., showing where each horse trough, each well, each storehouse is. Map-making has long been a function of engineers; and the most marked improvements have been in the main mechanical, first in introducing quickly on a map the revelations made by aerial photographs, second in increasing the speed of production of a map. In many cases, entirely new sets of maps are made each day, each one containing the information obtained within the preceding twelve hours.

Maj. Gen. George O. Squier, Chief Signal Officer, U. S. A.

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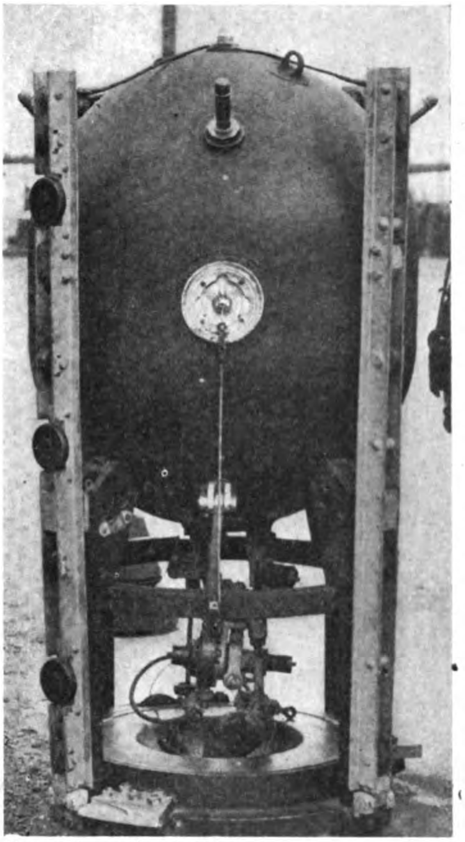
* Abstract of an Address at the University of Virginia.

Another department of science closely connected with airplanes and balloons is meteorology. We associate this word with weather prediction and with uninteresting data; but it must be remembered that these data include observations of temperature, of moisture content of the air, of air pressure, of wind direction and velocity at different heights above the earth. A knowledge of all of these is absolutely essential for each day's battle.



Press Illustrating Service

Mine taken from a captured U-boat now a souvenir on exhibition in England

Artillery at a long range is useless unless the temperature, the moisture content and the wind are known accurately. Gas attacks are controlled by the knowledge of winds and barometric pressure. The safe strata for airplanes must be known; and for long distance work weather prediction of every description is essential.

So important is the subject that observation stations with competent forecasters and scientific observers dot the battle-front at close intervals; and the home offices send almost hourly reports to the fleets and the coast-stations.

What strikes a layman most forcibly when inspecting a meteorological station near the battle-line is the rapidity of operation. Only minutes lapse between the observations and the deduction of the conclusion. One realizes then how much meteorology has grown into an exact science.

Modern artillery is a good illustration of the application of pure science. All of us are now familiar with the method by which artillery fire is controlled by the aid of airplanes; but you may not realize its wonderful accuracy.

If the enemy's battery is located, by any means, this implies that its position on a topographic map is known to within, say fifty feet, often less. It may be at a distance of ten, fifteen or more miles. Then to hit it, an exact knowledge of the properties of the powder used and of ballistics is required. With this, the target is reached in an astonishingly short time.

I have witnessed myself the destruction of a German battery at a distance of eleven miles by a French battery of three thirteen-inch guns, all done within ten minutes, the exact aim being secured after three salvoes.

The perfection of the mechanism of the French 75 and 37 millimeter guns is known to us all; but we hear much less of the English and American guns. I can assure you that this is only a curious bit of camouflage.

Of all the numerous ways in which physics has been called in to assist artillery, I know none so interesting as is illustrated by anti-aircraft gunnery. The problem is most difficult. An airplane may be traveling at a speed of 100 or 10 miles an hour, it rarely keeps a constant course, it may be at a height above the earth of 20,000 feet, nearly four miles. The man aiming the gun must know the position of the airplane and its speed, and then must make his calculations so that when his shell reaches the immense height, it shall be so timed as to meet the airplane.

It is true that it is rather a question of the airplane meeting some fragment of the shell, than the converse; but the problem is the same. When it is realized that numerous hits are recorded at heights of 20,000 feet, and when one hears the personal experiences of the pilots, it is clear that the problem has been solved fairly well. A former student of mine writing to me a few days ago, after telling how he had "speared his first Hun" on his first day at the front, added that the German shells rarely missed him by more than ten feet, and he was flying a rapid scout machine and was manouvering for position all the time.

I am familiar with the French and British methods of aiming their guns; and, as you can yourself decide from reading the newspapers, they are not inferior to the ones used by the Germans.

One can not speak of artillery without thinking of gas shells and gas attacks. The Germans were the first to use this hideous means of warfare, although it is well known that it was proposed to the British war office many years ago and the decision was reached that it should not be adopted.

When poisonous gases first became a weapon, it was in the form of gas clouds, rolled along the ground by the wind, the gas having been released from cylinders in the front line of trenches. For perfectly obvious reasons this mode of gas attack was soon replaced by the use of large shells filled with the liquefied gas. When the shell was exploded by a contact- or a time-fuse, the gas would escape and work its action in all the neighborhood.

There are two problems associated with this mode of warfare: an offensive and a defensive one. The former is to make a gas which can be liquefied, is not so light as to diffuse upward too rapidly, and which will either kill the man who breathes it or will in some way incapacitate him; the latter is to make a mask or a suit of clothing, if necessary, which will enable the wearer to breath and do his work in the contaminated atmosphere.

We hear most of course about the terrors of the gases used by the Germans; but, if they would only describe to us their feelings about the gases sent them, our point of view would change. Some might even have a feeling of pity.

Both the questions, of defense and offense, are strictly scientific ones, in the main belonging to chemistry. The researches undertaken in Great Britain, France and this country are so numerous that the truth is almost unbelievable. It is safe to say that there are at least 2,000 chemists in America alone working on problems connected with the military use of gas.

We can well be proud of the achievements of our chemists. Among many things which I may say I shall select two: they have devised a mask for use inside a gun turret on our large ships where a particularly dangerous gas is liberated during a battle, and the masks supplied our soldiers are at least 20 per cent. better than either the British or French mask, and they are better than the German model.

As another illustration of the usefulness of chemists in this war, one should state what has been done by them to render the allied countries and our own independent of Germany from an economic standpoint. All I shall do, however, will be to mention two subjects: dye-stuffs and drugs; and you know the rest. It should be remembered, though, that this is not the full story, only an interesting chapter.

One of the most important military questions, which in the end is a purely physical one, is that of signals. Our army is most fortunate in having as its Chief Signal Officer a man who is a doctor of philosophy in physics, from Johns Hopkins University, Major General George O. Squier. He certainly knows his subject from the scientific standpoint as few military officers can know it.

Think for a moment of the variety of signals required. Those to and from airplanes and submarines have been referred to. In addition, each trench, each outpost, each reserve force, each artillery battery must be in unbroken communication with the brigade headquarters, and the division and staff officers. Wireless telegraphy and telephone are used in various ways; ordinary telephones are installed everywhere; carrier pigeons must be bred and trained; signals using both sound and light are most useful. It is not merely a matter of perfecting signals which work satisfactorily; much more is required, safeguards must be devised which make it impossible for the enemy to observe or read them. When I say that all this has been done, and done to a large degree by our American physicists, I am telling only the bare truth. I wish it were permitted to tell more.

Signals as used by the Navy are not as varied as those required by the Army. But there is one special problem which concerns the American Navy more than any other. In sending ships and transports to Europe in large groups, at night no lights are shown by any vessel; the question then arises, how is it possible to maintain relative distances and positions? This sounds as if it were an almost hopeless proposition; but it is not; and I have seen a solution which seems satisfactory, again the ingenious idea of an American physicist.

The demands upon photography are great, largely in connection with airplanes; and the methods elaborated by the British and French scientists are beautiful. There are other phases, though, of almost equal importance. Can we not take photographs of objects which the eye can not see, owing to clouds, haze or distance? This matter is solved in a large degree as a result of our spectroscopic knowledge.

By photographic methods it is possible to discover the location of the enemy's batteries unless they are hidden with the utmost care.

In this last case resort is had, as you know, to what is called sound-ranging. When a gun ejects its shell in the direction of the enemy, the latter hears in succession three sounds; first that due to the passing of the shell through the air, in general a hissing sound; then the proper sound from the gun mouth, a boom; and finally the sound of the explosion of the shell. Sound waves travel through the air with a comparatively slow velocity, slightly over 1,000 feet per second, and so if observing stations are placed at different distances from the gun, any one type of the three sounds, *e. g.*, the boom, will be heard at different instants of time. It is easily seen, then, that methods may be devised by means of a system of triangulation, by which the location of the gun may be determined. The accuracy of the methods in use is so great that now within a few minutes after the firing of a gun its position is known definitely to within limits less than the accuracy of the guns which are responsible for the destruction of the enemy's battery. This last limitation is due to an unavoidable variation in shells and their powder charges, and to variations in the atmosphere.

International Film Service

First aerial ambulance in air service of U. S. Army—Photo shows the ambulance attendants lifting a wounded soldier upon a stretcher into the berth of an airplane

This method of sound-ranging is simple in theory, but extremely difficult in practise, owing to vagaries of the wind and to the confusion caused by simultaneous discharges of guns. The former difficulty has been overcome by a brilliant British physicist; but, as you have probably seen in the papers, one of the ways used by the Germans to conceal the position of its big guns by which they were bombarding Paris was to discharge a dozen other guns simultaneously.

A somewhat similar problem arises in connection with determining the position of an airplane at night, or in cloudy weather. One inherent difficulty here lies in the great speed and great height of the airplane. Rumors have reached us that the British have found a method; but, whether this is true or not, the problem is not hopeless. The airplane in flight emits sounds, loud ones; with that fact as a basis, its detection is therefore certain.

I am not sure that any of you would of your own account think of astronomy as being a practical science; yet there has been found a definite usefulness for the disturbances on the sun, known as sunspots; and astronomers easily turn from calculations of the motions of comets, planets and satellites to those of twelve-inch shells and bombs dropped from airplanes. The instruments used by navigators on the sea and in the air when the flights are long are essentially those invented and adopted by astronomers. In fact an American astronomer has perfected within the past few months an entirely new instrument for the use of navigators, an instrument which will mean a great deal to both our sea and our air force.

Another science which seems remote from war is geology, and yet it has proved not simply useful, but essential. The minute you realize that war is concerned with trenches, dugouts, military mines, tunnels, water-supply, etc., you see that here the geologist must be summoned to help. He alone knows from his maps, made in times of peace, how to plan for any emergency requiring one to go below the surface of the earth.

There is a group of sciences, not physical, which has, in the end, the greatest responsibility in bringing victory to our arms. The men who are directing the work, in the laboratory and in the field, are university men almost without exception. This group includes experimental psychology, medicine and surgery and hygiene.

The function of the first of these is to devise such tests that we may be reasonably sure that a man selected for a certain duty can perform it. As a simple illustration, think of an airplane pilot. It is not difficult to analyze his responsibilities and to state the qualities which he should possess; further it is not impossible to devise experimental tests which may be performed on the ground in order to see if he has these qualities or, if not, to see whether he can acquire them in a short time. Our aviation section of the army has equipped laboratories along these lines, and the results obtained are most interesting. Certain generalizations will undoubtedly be deduced, and the examination of candidates can proceed more rapidly.

As soon as our military departments can be persuaded to recognize the fact that experimental psychology can in many, if not all, cases state definitely that a man with such and such reactions ought not to command a company, a regiment or a ship, our fighting forces will become efficient, not before.

The varied activities of our medical departments are known. When I think of them, what is uppermost in my mind is their progress in combating disease. I may be pardoned for speaking of two illustrations.

The gas-bacillus, the cause of hospital gangrene, has lost its terrors absolutely; first by the Carrel-Dakin treatment of wounds, second by Dr. Bull's discovery of a serum which may be used exactly as diphtheria antitoxin is used. Dr. Carrel is a Frenchman and Dr. Dakin is an Englishman; but both have lived long in this country; and Dr. Bull perfected his method at the Rockefeller Institute, New York.

My second illustration is the discovery of the means by which trench fever is conveyed from patient to patient. This is not a dangerous disease, but is one which renders soldiers non-combatants for the time being. This discovery has just been made in France by two of our American doctors, both attached in normal times to American universities.

You are probably saying to yourselves, "Yes, this is interesting to hear about the scientific achievements of ourselves and the Allies; but what is the real use of it, when Germany, which leads the world in all branches of science, is our enemy?" No educated man should assert that Germany is the leader of the world of science. It is true that Germany modestly acknowledges it, and every American newspaper supports the claim in ways both direct and insidious. The facts, however, do not support it. Many years ago it undoubtedly was true, but a full generation has passed since then.

The Prussian form of government does not encourage individuality or freedom of thought; and these are essential for scientific discoveries and scientific development. In all seriousness I maintain that Germany has not been fruitful in ideas for many years in any of the experimental sciences, with the exception of medicine. In the fields of physics, of chemistry, of meteorology, of metallurgy, you must look for the leaders in other countries.

It may be true, although I doubt it, that Germany had the best generals, the best guns, the best ships; she certainly had the largest army and the power to bear upon any point the greatest force; but this condition has passed.

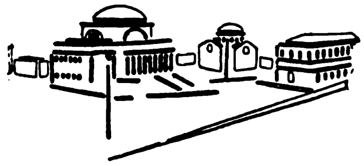
There were two agencies at work in this country which in reality were most powerful sources of German propaganda. One of these was the interpretation given to news from the war by our public journals, and the emphasis placed upon German successes. In part this is due to the lack of realization by the managers of the papers of their responsibility in the matter, but in larger part to that policy of a newspaper office which leaves the writing of the headlines in the hands of inexperienced, comparatively uneducated young men.

The other agency of German propaganda, and a much more vicious one, was the policy adopted by our own government in regard to giving out official information. The whole policy was wrong, and should have been changed. The people have lost confidence in the government agents, and rightly so; they are either optimistic to a ridiculous degree or boastful. What is required is that the government must realize the tremendous responsibility of the office charged with the dissemination of news. There is no man in America too great for this task. He must command the absolute confidence of every one; he must be able to speak the truth and nothing but the truth; he must understand the thousand phases of the war, looked at from a military, a medical, a scientific, a social standpoint; above all he must be allowed to give the American people real information in regard to the efficiency, the achievements of our people and of the Allies.

It is one of the real tragedies that the American people are so often deceived and are not told the truth about so many matters which concern them so vitally. If our people could only have realized the exact situation, Germany would have lost half her power, because in fact the American people were afraid of her, a condition which is absurd.

The time has come for America to recognize the usefulness of the scholar, the thinker, the investigator of science. All the other countries of the world have done so long since. It is only in regard to such experimental sciences as physics and chemistry that there is this failure in this country to appreciate the services of its experts.

Progress In Radio Science



Langmuir's Beat Receiver Circuits

SEVERAL circuits have been patented by Irving Lanmuir for the reception of undamped waves by the beat phenomenon. They are shown in the accompanying drawings figures 1, 2 and 3. In figure 1 there is coupled to the plate circuit of the vacuum tube the alternator 12 through the inductance 13 which acts inductively on the plate circuit at coil 11. In the diagram of figure 2, a cascade amplifier is shown where the plate and grid circuits of the first and second valve respectively are coupled through a high resistance 13 shunted by a variable condenser 14. In figure 3 the radio frequency alternator is coupled directly to the antenna through the inductance 22 and 23 and the amplitude of the locally generated current is regulated by the resistance R. This is distinctly necessary for maximum amplification.

Langmuir's explanation for the operation of these circuits is as follows:

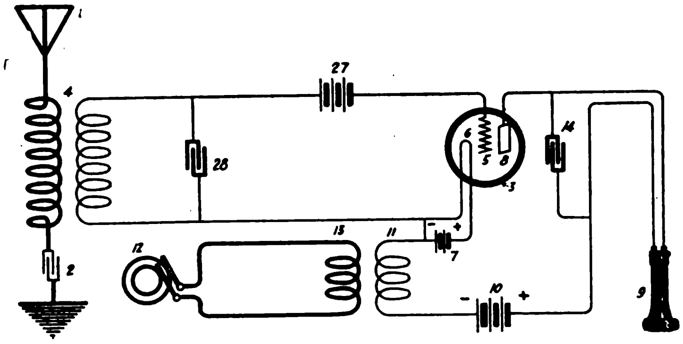


Figure 1—Showing plate circuit of the vacuum tube coupled to alternator

When the frequency of the received waves and of the locally generated waves differ there will be periods when the anode 8 is positive and the grid 5 is positive at the same time. The length of these periods will of course depend upon how near the two sets of waves approach phase opposition. There will also be similar periods when the anode is positive and the grid negative, when the anode is negative and the grid positive, and when the anode is negative and the grid negative. Current will flow freely through the plate circuit, however, only during those periods when the anode is positive and the grid positive. The length of these periods and the amplitude of the current flow will increase from zero when the two waves are in phase, to a maximum when the two sets of waves are directly opposite in phase and will then decrease to zero again. Inasmuch as these periods during which current will flow are of very high frequency, each individual impulse of current will have no effect on the telephone receiver. In combination, however, the impulses will have the effect of a continuous current which gradually increases in amplitude from zero to a maximum value and then decreases again to zero and as a result beats will be heard in the telephone, the frequency of the beats being dependent upon the group frequency of the current impulses set up in the plate circuit and this group frequency in turn being equal to the difference in frequency of the two sets of waves.

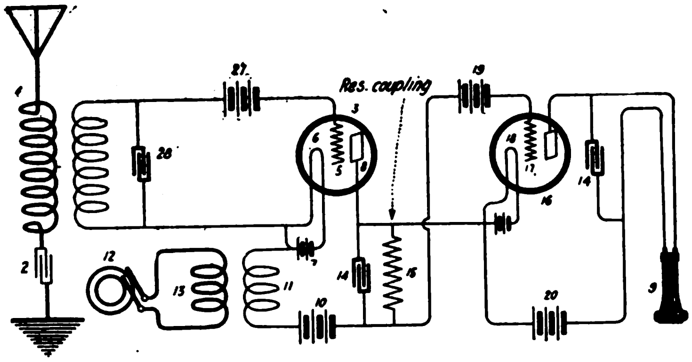


Figure 2—Showing a cascade amplifier

With this arrangement the only signals which can be received are those which are transmitted by means of waves which differ in frequency from those produced by the local source by an amount which is within the range of audibility of an ordinary telephone receiver. Waves which differ in frequency from the locally produced waves by a greater or less amount than the audible frequency of the receiver will produce no effect.

In some cases it may be desirable that the positive half wave of the local source which is impressed upon the anode be made greater than the negative half wave. To provide for this a battery 10 may be employed having its positive pole connected to the anode. The successive impulses of current which flow in the plate circuit, having a high frequency, would be choked back by the inductance of the telephone receiver. To prevent this a condenser 14 may be shunted across the terminals of the receiver. In some cases it will be found desirable also to employ a battery 27 in order that the numerical value of the negative potential imposed upon the grids 5 and 24 may be greater than that of the positive potential. It may even be found advantageous in some cases to make the battery so large that the potential of the grid will always be negative. On the other hand, it may be found desirable in some cases to so connect the battery that a positive potential will be imposed on the grid. It will of course be understood that other suitable forms of current operated devices than a telephone receiver may be used for receiving the signals.

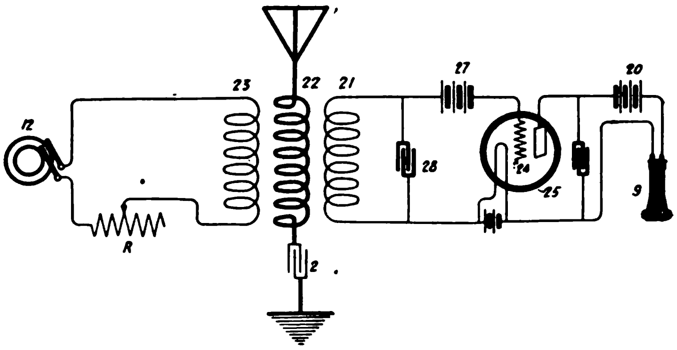


Figure 3—Circuit showing radio frequency alternator coupled directly to antenna

In some cases the energy of the received waves may be so small that the amount of energy which may be controlled thereby in the plate circuit of the tube will be too small to give an easily audible signal in the telephone receiver. In such cases, however, the current fluctuations produced may be easily amplified by the arrangement shown in figure 2. In place of the telephone receiver in the plate circuit in this case we may use a high resistance 15 which is also connected in the grid circuit of a second electron discharge tube 16. This circuit in addition to the grid 17 and the cathode 18 may also include a battery 19. This battery may be so connected that normally the grid 17 has a positive charge. In this case current from the local battery 20 will always flow in the plate circuit of the second tube in which the receiver 9 is included. When current flows through the plate circuit of the first tube the drop of potential in the plate circuit will principally take place in the high resistance 15, and this will cut down the positive charge on the grid 17 due to the battery 19. This will decrease the current flow through the plate circuit of the second tube and the current fluctuations set up in this manner will produce beats in the telephone receiver in a similar manner to that described in connection with figure 1.

The Thermic Telephone as an Oscillation Detector

PROF. DR. HENDRIK ZWAARDEMAKER of Utrecht, Netherlands, has shown a circuit for the reception of electrical oscillations wherein the thermic telephone is employed as a detector. He has observed that the sensitiveness of the thermic telephone when used as an oscillation detector can be considerably increased when it is polarized, for example, by pre-heating it with a direct current.

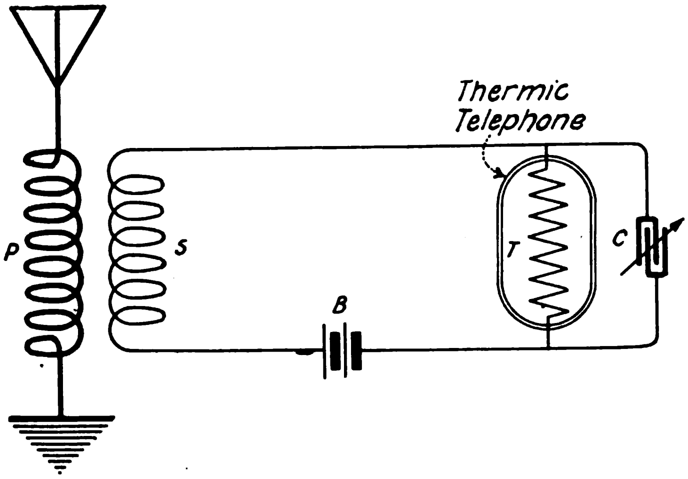


Figure 1—Thermic telephone used as an oscillation detector

In accordance with his invention he corrects the apparatus as shown in the diagram of figure 1 where the primary of an oscillation transformer is indicated at P and the secondary at S, the thermic telephone at T shunted by a variable condenser C. The source of direct current, B, is included in series with secondary winding of the receiving transformer and the telephone T.

Prof. Zwaardemaker insists that the circuit shown in this diagram is sensitive and the apparatus will respond to very weak signals. There must, however, be a certain relation between the resistance of the thermic telephone and that of the secondary coil S. The air space within the thermic telephone should be as small as possible and, in general, its resistance should be rather high.

Dubilier Vibrator Transmitting Sets

A NOVEL apparatus for the production of electrical oscillations has recently been shown by William Dubilier in which a vibrating contact constitutes the spark discharge gap of a closed oscillation circuit. The method of using is shown in the accompanying drawings figures 1, 2, 3 and 4.

The construction of the vibrator is shown in figure 1, where a vibrating element O carries a contact D-1 which makes contact with a stationary electrode D-2. The electromagnetic winding A serves to open and close the contacts D-1 and D-2.

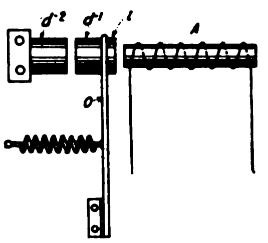


Figure 1—The construction of the vibrator transmitting set

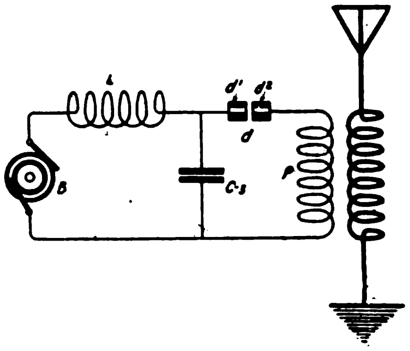
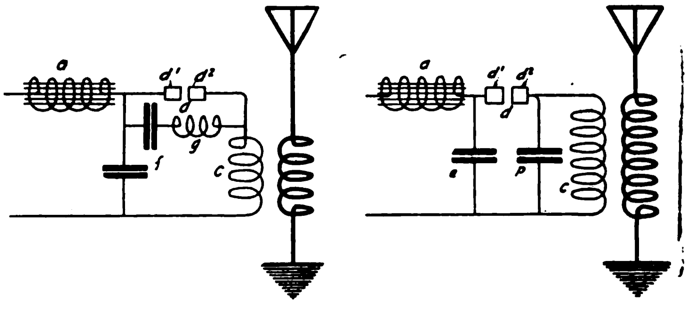


Figure 2—The interrupter spark gap

In the diagram of figure 2, the interrupter spark gap is shown at D, a source of energy at B which may be direct or alternating current, an inductance at L in series with the spark gap and generator, and the primary of the oscillation transformer at P. The complete radio frequency closed circuit comprises the spark gap D, the variable condenser C-3 and the primary P.

The operation of the apparatus has been explained as follows: The current passing from the generator B through the inductance L, through the transformer primary P is broken at contacts D-1 and D-2. The condenser E is in parallel with the gap D and is charged by the action of the arc across the gap. Inductance L prevents the high frequency current set up in a circuit D, C-3, P from traveling back through the generator and also assists in charging the condenser due to its self-induction when the circuit is broken at D.

The inventor declares that the apparatus operates efficiently when the period of vibration of the spring in the vibrator has a selected ratio to the natural frequency of the oscillating circuit D, C-3, P, that is, when its period of vibration is either equal to, or a harmonic of, the natural frequency of the oscillating circuit.



Figures 3, 4—Modified circuits of the vibrator transmitting set

Modified circuits are shown in figures 3 and 4 where a capacity F and an inductance G are placed in parallel with the interrupter D (figure 3). In figure 4, the condenser P is placed across the primary of the oscillation transformer C. Inasmuch as a simple electromagnetic vibrator is used to produce oscillations, the cost of manufacture is correspondingly less; and moreover because a closed circuit is obtained in starting the oscillations, a high primary potential is not necessary. A direct current source at low voltage is sufficient to operate the apparatus efficiently, the potential of the oscillating circuit being raised by the opening of the gap D-1 and D-2 and the inductance A. The inventor states that the apparatus is particularly useful for airplane work. He gives us no information concerning the constants of the circuits employed nor any formula by which the proper proportion of the inductances and capacity are secured.

The inventor mentioned that the circuit produces oscillations having the characteristics of undamped currents for a certain period and a damped or quenched characteristic for a further period.

It would seem from the explanation given that the radio frequency oscillations take place, for example, in circuit D, C-3, P of figure 2 at the time that an arc occurs between the electrodes D-1 and D-2 and at further opening of the electrodes, the arc is extinguished and the oscillations then cease.

Valve Circuits for Radio Reception and the Generation of Sustained Oscillations

IMPROVED circuits for the use of the vacuum valve as a detector of damped and undamped oscillations have been devised by Roy A. Weagant, Chief Engineer of the Marconi Wireless Telegraph Company, as shown in the accompanying figures 1 and 3. Figure 2 is a circuit which may be utilized for the production of sustained oscillations for transmitting purposes, but which is also applicable for radio reception. The construction of the vacuum tube is shown in figure 4, being an improvement on the well-known Fleming valve patented in 1905. It contains a plate P and a filament F surrounded by a copper sheath K and which is preferably electroplated to the glass. The sheath is of sufficient area to practically enclose both electrodes.

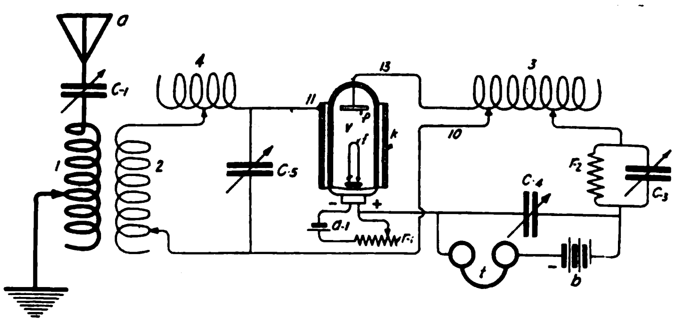


Figure 1—Weagant's circuit for the use of the vacuum valve as a detector of damped and undamped oscillations

The circuit in figure 3 can be made to generate oscillations in groups at frequencies above or below audibility and therefore can be employed for wireless reception by the beat phenomenon. Generally speaking, the vacuum of the tube when used as in figure 3 is such that the application of 100 volts or less between the plate and filament will produce a visible blue glow or arc like effect. The apparatus shown in figure 1 will generate sinusoidal currents at any frequency and not in groups as the apparatus in figure 3.

An important addition to these circuits is the use of resistance R-2 in the plate circuit, shunted by the variable condenser C-3. When this resistance is very high and of the order of that of the internal resistance of the valve itself, it permits the plate voltage to be adjusted to a higher value than is desirable without its use, enabling the operator to get a critical adjustment of gas ionization so that minute electrical disturbances impressed upon the tube causes a great increase of current through the telephone T. The resistance contributes materially in obtaining the adjustment whereby automatic interruption of the local plate current is obtained enabling the valve to generate alternating currents in groups of damped oscillations.

The inductance 3 in the plate circuit of figure 1 performs several novel and important functions. By careful adjustment of its value, marked amplifications of the incoming signal are obtained. The maximum amplification is usually secured when the frequency of the plate circuit corresponds closely to that of the associated circuits to which the sheath is connected. By the use of this inductance the valve becomes a generator of sinusoidal oscillations without depending upon any particular critical value of ionization within the bulb. As a matter of fact in contrast to the circuit in which this inductance is not employed, better results are obtained with a tube in which the vacuum is as perfect as possible.

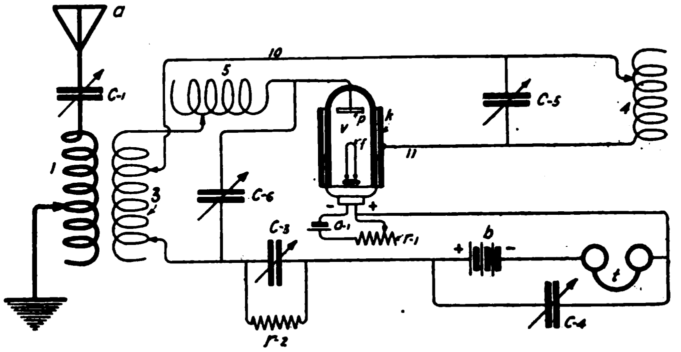


Figure 2—Circuit for producing sustained oscillations for transmitting—is also applicable for radio reception

When the apparatus shown in these diagrams is used as a receiver of spark signals, the circuits are tuned so that the valve is just on the verge of oscillation; on the other hand for the reception of undamped waves, the valve is made to oscillate at a frequency slightly different from that of the incoming signal producing a beat current. Another advantage of the inductance element 3 in figure 1 is that it will amplify weak signals whereas with the circuit of figure 3 wherein this inductance is eliminated, there is a minimum strength of signal below which the circuit will not amplify.

The inventor remarks that with the circuit in figure 1 it is possible to start with a signal which is below the low limit of the device when the inductance is not present and amplify it considerably. Added to this, we may have the amplification due to the critical gas ionization within the valve. The combined effects bring about an enormous increase in the original strength of the signals.

Still better signals can be obtained from certain types of valves by providing coupling between plate and secondary windings of the circuit as shown in figure 1 where a wire 10 is tapped off inductance 3. Direct coupling is thus obtained, but inductive or electrostatic coupling might be used as well. In the diagram of figure 2, the antenna circuit is coupled to the plate circuit inductance 3, the grid circuit being tapped off 3 by wire 10. This circuit also includes inductance 4, shunt condenser C-5 and the sheath K. This circuit constitutes a powerful oscillation generator but may be used for beat reception as well.

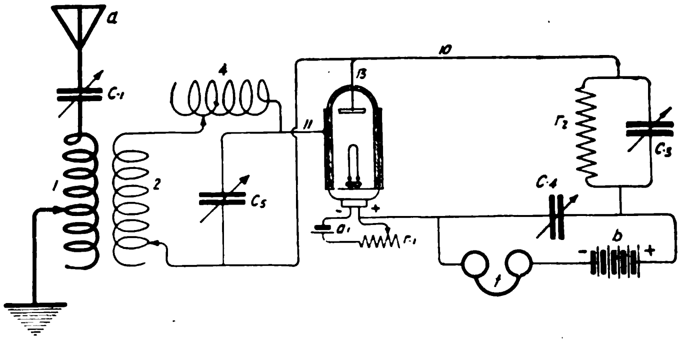


Figure 3—Another form of Weagant's improved circuit

Practical Wireless Instruction

A Practical Course for Radio Operators

By Elmer E. Bucher

Director of Instruction, Marconi Institute

PART II—ARTICLE III, OF WARTIME WIRELESS INSTRUCTION

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Editor's Note—Part 1 of this series of lessons began in the May, 1917, issue of The Wireless Age. Successive installments were devoted to the fundamental actions of radio transmitting and receiving apparatus for the production and reception of damped oscillations.

Part 2, the present series, will deal with undamped wave generators, including bulb transmitters and receivers for the reception of undamped oscillations. The direction finder and other special appliances employed in radio telegraph work will be treated fundamentally. A discussion of the basic principles of wireless telephony will terminate the series.

The outstanding feature of the lessons has been the absence of cumbersome detail. The course will contain only the essentials required to obtain a government *first grade commercial license certificate* and to supply the knowledge necessary to become a first rate *radio mechanic*.

REFLECTOR ALTERNATORS

(1) In the radio frequency alternators previously described, **radio frequency currents were generated by providing the dynamo rotor with a great number of teeth, the rotating** member being driven at very high velocities. Some of the mechanical and electrical problems involved in such design have been dealt with briefly in the previous issue.

(2) Alexanderson has developed a special radio frequency alternator which we have not described, wherein frequencies up to 200,000 cycles per second were secured by providing **an armature with two-thirds as many slots as the effective number of field poles. Acting on the vernier principle, the frequency of such a machine is equal to the number of field poles on one side multiplied by the speed of the armature per second.**

(3) In the **reflector type** of alternator here to be described, frequencies are multiplied within the same machine. By the use of a relatively low speed armature, radio frequencies up to 60,000 or 80,000 cycles per second can readily be obtained. It is more usual, however, to design such machines for frequencies around 40,000 cycles per second, corresponding to wave lengths between 7,000 and 8,000 meters.

FUNDAMENTAL PRINCIPLE OF THE FREQUENCY MULTIPLYING ALTERNATOR

(1) The student familiar with the operating principle of the **induction motor** is aware that it consists of a **stator** and **rotor.** In the stator a group of fixed windings are so arranged that a two phase current, for example, produces a magnetic field which rotates at an angular velocity determined by the frequency of the alternating current. The **rotor or armature** consists of coils wound in slots, which are short circuited and in which the changing flux generated by the field poles induce a current. The flux generated by the armature current reacts upon the field poles and the armature is set in rotation in a definite direction.

(2) A **rotating magnetic field** can be produced by a polyphase (two or more phases) current or by a single phase current provided that, in the latter case, two field windings are supplied and are so designed that the two resulting magnetic **fields generated thereby are out of phase.**

(3) A single phase current flowing in a single set of field coils of an induction motor does not, however, produce a unidirectional rotating magnetic field, but a field which alternates in direction and changes in intensity. In the case of the induction motor the field would have a tendency to turn the armature first in one direction and then in the opposite direction with no resulting motion. However, the magnetic field resulting from an alternating current flowing in the stator winding may be thought of as **two equal and oppositely rotating fields** which can be put to account in the **multiplication of radio frequencies** within a radio frequency alternator. This is done in the Goldschmidt reflector alternator.

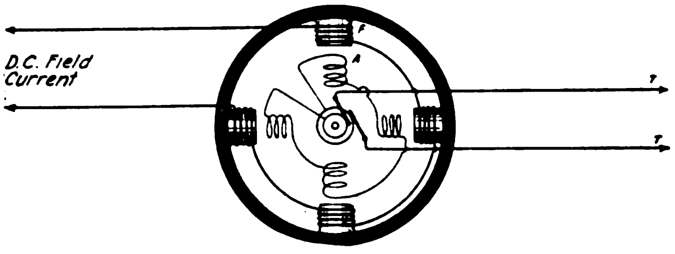


Figure 193

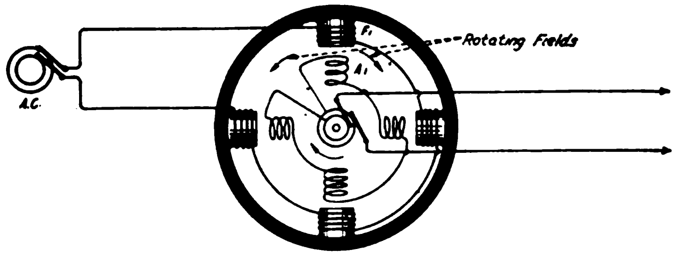


Figure 194

OBJECT OF THE DIAGRAM

To show how an alternating current may be doubled in a generator, the field coils of which are excited by alternating current.

DESCRIPTION OF THE DRAWINGS

Figure 193 represents a simple alternator, with four field poles F, fed by DC current from an external source. The armature coils are indicated at A, the collector rings at N and the external circuit at T. The speed of armature, for purposes of illustration, is assumed to be 1800 revolutions per minute.

Figure 194 is a similar diagram, but in this case the field windings are excited by alternating current of the frequency that would be obtained in figure 193, with DC excitation current, and an armature speed of 1800 R.P.M.

OPERATION

The speed of the armature is 30 revolutions per second and therefore in one complete revolution there will be 4 x 30 or 120 changes of flux through its windings. This will induce 120 alternations of current in the armature coils, giving a frequency of 60 cycles per second.

The terminals of this armature T are assumed to be connected to the terminals of the field coils in figure 194. Current of a frequency of 60 cycles will flow in the field circuit and the resulting magnetic field can be thought of as **two equal magnetic fields rotating in opposite directions.**

If, for example, the armature turns clock-wise, at a speed of 30 revolutions per second, no cutting will result in respect to the component of the field which rotates clock-wise and therefore no current will be induced in the armature coils A', but in respect to the field which rotates in the opposite direction it is clear that the relative motion is **twice the velocity of** the armature, because the **field rotates in one direction at a given velocity and the armature rotates in the opposite direc-**

(*Continued on page 19, first column*)

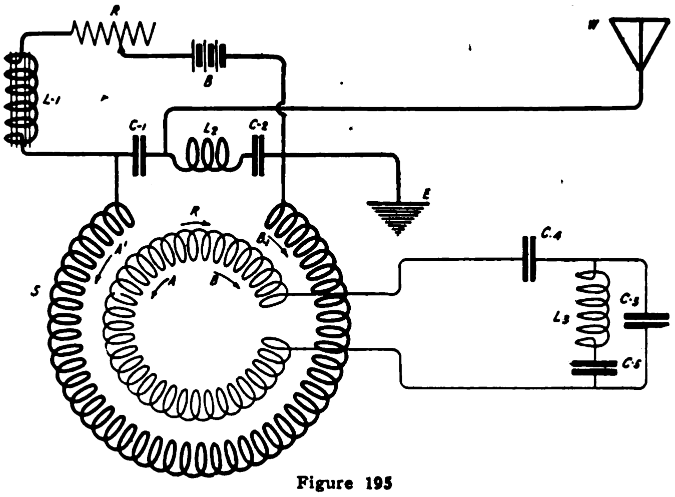


Figure 195

OBJECT OF THE DIAGRAM

To indicate the fundamental principle of circuits of Goldschmidt's radio frequency alternator.

DESCRIPTION OF THE DRAWING

A stationary DC field winding known as the **stator** is indicated at S and the **rotor** or **armature** at R.

Winding S is set into excitation by a DC source B in series with which is the **rheostat** R and the **impedance** L-1.

Since the impedance of the rotor and stator circuits of the alternator must be reduced to a minimum for four frequencies, the rotor and stator terminals are short circuited by the inductances and capacities shown. For example:

In the case of the rotor:

Condenser C-4, inductance L-3, condenser C-5 short circuit the rotor R for the frequency of 15,000 cycles. (That is, inductance L-3 and condenser C-5, short circuit R and C-4).

Condensers C-4 and C-3 short circuit the rotor for 45,000 cycles.

In the case of the stator:

Condenser C-1, inductance L-2 and condenser C-2 short circuit the stator S for the frequency of 30,000 cycles.

Condenser C-1 and the electrostatic capacity of the antenna to earth, short circuit stator S for 60,000 cycles—the desired antenna frequency.

It is to be noted that condenser C-4 alone would short circuit the rotor, but in order that a separate path may be supplied for the current of 45,000 cycles, a second circuit of the same magnitude as R, C-4, namely L-3, C-5 is connected in series. By this connection we have doubled the inductance and halved the capacity, making no change in the fundamental frequency of the circuit. The rotor remains on short circuit to the fundamental frequency of 15,000 cycles per second and another path through C-3 is provided for the frequency of 45,000 cycles without changing the tuning for the other frequency.

The same explanation applies to the stator, the product of S and C-1 equalling the product of L-2 and C-2.

OPERATION

For purposes of illustration we have indicated the two oppositely rotating magnetic fields of the stator and the rotor by the arrows A' and B' for the stator, and A and B for the rotor.

The stator S is provided with the correct number of poles so that the initial frequency of the current generated in the rotor R is 15,000 cycles per second. This current flows through C-4, L-3 and C-5.

The magnetic field of the rotor resulting from this current can be thought of as two oppositely rotating fields represented by the devices A and B. If the armature be assumed to rotate clock-wise, component A (since it is opposite to the direction of rotation) will produce no effect upon the stator winding because the velocity of the rotating field and the armature are the same and in opposite directions, but the component B rotates in the same direction as the armature and at the same velocity. We may therefore consider the field of the rotor to be produced by an alternating current of a frequency N rotating at a frequency N and the component B will cut the stator S at a frequency of 2N or 30,000 cycles. This current is increased in magnitude by short circuiting the armature with condenser C-1, inductance L-2 and condenser C-2.

With reference to the stator S, the current of 2N produces oppositely rotating fields indicated by the devices A' B'. The rotor R cuts through B' at one-half the velocity of B' (which is equal to 2N) inducing in R a frequency of 15,000 cycles or N, which frequency neutralizes the former frequency of N. In respect to component A' the relative motion is obviously 3N, for the armature rotates in one direction at a velocity equal to the frequency N and the component A' in the opposite direction at a velocity equal to 2N. The resulting frequency is therefore 3N (or 45,000 cycles per second) which flows through condensers C-4 and C-3.

We may now resolve the current of 3N in the rotor R, into two oppositely rotating fields, using again the devices A and B. We must keep in mind that the armature rotates clockwise at a velocity equal to the frequency N. In respect to component A the relative cutting upon the stator is 3N—N or 2N (30,000 cycles per second) which current neutralizes the former current of 2N in the stator.

In respect to component B, we may consider it as a field of 3N rotating at a frequency N and its velocity in respect to the stator is 4N or 60,000 cycles. This current flows through C-1, the circuit being completed by the electrostatic capacity of the antenna.

SPECIAL REMARKS

(1) Reflector alternators of 200 kw. output have been constructed and placed in actual operation. They are driven at speeds between 3,000 and 4,000 revolutions per minute and are supplied with 360 field poles.

(2) The rotor is made of fine iron laminations .002 inch in thickness; the laminations being insulated from one another by thin sheets of paper. In fact, the rotor of the machine is one-third paper. The air gap clearance between the rotor and stator is .03 inches, which requires very accurate design throughout.

(3) The stator and rotor windings are similar in design, consisting of one conductor per pole. As in other radio frequency alternators U shaped windings are employed. In order to prevent excessive rises of potential in the alternator circuits, the rotor and stator windings are wound in sections permitting either a series or a parallel connection. The conductor of the rotor and stator is made up of a number of very fine wires in the form of a cable, the wires being insulated from one another by an enamel coating.

(4) **Signaling** is accomplished either **by change of inductance** in the antenna circuit, as in the arc system, thereby tuning and detuning the antenna circuit each time the key is pressed, or the key may be inserted in series with DC excitation circuit. Special precautions had to be taken in the latter method of signaling for each time the field windings were demagnetized, the load was taken off the driving motor, causing a great variation in speed, throwing the machine out of resonance with the antenna circuit. To offset this, a double contact telegraph key is provided which, when the DC excitation circuit is closed, inserts a resistance in series with the field circuit of the driving motor. The reduction of field current increases the driving force just sufficiently to maintain normal speed under change of load.

(5) The reflector alternator is not suitable for radio transmission at variable wave lengths. It is evident that a rapid change from one frequency to another cannot be obtained and beyond this the best efficiency is obtained at some constant speed. Alternators of this type are only applicable to transmission between land stations, operated at fixed wave lengths. Viewed from all standpoints, it is doubtful whether they will have any considerable commercial application.

(6) Complete resonance between the antenna circuit and the desired alternator frequency is established by an aerial tuning inductance.

(*Continued from page 18*)

tion at the same velocity. There will, therefore, flow in the armature of figure 194 a current of **double frequency.** This current can be fed to the field windings of another generator and the frequency again doubled, but as will be shown this multiplication can take place within the same machine.

SPECIAL REMARKS

(1) In figure 194 the armature A' is rotated at synchronous speed. If it revolves out of synchronism with the two magnetic components of the stationary field coils, it can be shown that two frequencies will be generated in the armature; that is, if the frequency of the field current is N_1, and the speed of armature is such that if the field windings were excited by DC current, its frequency would be of different value N_2, then the frequencies of the two resulting currents in the armature circuit will be N_1+N_2, and $N_1—N_2$.

(2) In the Goldschmidt reflector alternator, owing to the fact that the generation of radio frequency currents is involved, tuned circuits must be provided in order to reduce the impedance of the armature and field circuits for several frequencies. The phenomenon of rotating fields is employed as in the above illustration and the armature is driven at such speeds as will permit the desired multiplication of frequencies to take place.

Radio Frequency Changers

Reported Progress in Their Application to Radio-Telegraphic and Telephonic Communication

By E. E. Bucher

Director of Instruction, Marconi Institute

(*Continued from the December,* 1918, *issue of* THE WIRELESS AGE)

Control of Antenna Currents

IN order to control the antenna current in the Arco-Meissner frequency changer system, it has been found of advantage to divide the auxiliary magnetizing circuits as in figure 17. Here the last group of frequency changers is indicated at C with the primary windings P, S, and the secondary windings P′, S′. A source of direct current B through the windings EE nearly saturates the core of the yokes Y and Y′. The circuits are arranged so that with the degree of magnetization afforded by this circuit, the antenna circuit including the secondaries P′ and S′ is slightly off resonance with the radio frequency changers. Then by closing the key K, the yokes are further magnetized from a separate source of direct current B′ thereby establishing complete resonance with the antenna system. The coils E′ E′ are therefore designed to provide the additional magnetizing force required to saturate the core. This connection gives the advantage that the electrical control of the saturation circuit and the signaling circuit are separate.

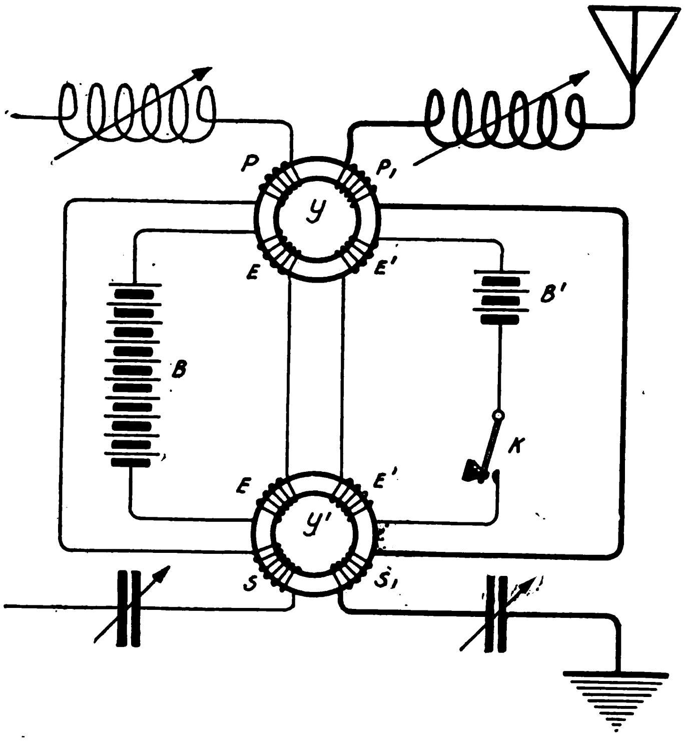


Figure 17—Split key control circuit of the Arco-Meissner system

Signaling at tone frequencies may be accomplished by substituting for the key K a magnetic interrupter or for wireless telephony a microphone for the transmission of speech. The inventors' remark that this separation of two magnetizing circuits is of particular advantage in case tone frequencies are secured by means of alternating current at audible frequencies circulating through excitation windings E′.

UNIVERSAL TYPE OF TRANSMITTER

We have shown in the previous article, the circuits of a complete station provided with means for the production of undamped oscillations for telegraphy or telephony, or for the production of groups of damped oscillations all from the same source of current—a radio frequency generator. The diagram which reappears in figure 18 will now be described more in detail. All these arrangements are confined to the same piece of apparatus and by means of a selective switch, not shown, the connections can be shifted from one system to the other as desired. For example, in figure 18 the yokes Y-1 and Y-2 constituting the last step of a radio frequency changer system carry the excitation windings E′ fed by the source of direct current B in series with which are the choking inductances I, the regulating resistance R, the shunt key resistance R-3, a telegraphic signaling key K-4, a separate telegraphic signaling key K-5 in series with which is the buzzer B-2. A special load circuit or dummy aerial is provided by windings S-5 and S-6, inductance L-1, the ballast R the variable condenser C-1, and the switch K-3. Several telephonic microphones M connected in series parallel and each group in series with an inductive resistance R-4 are shown. The source of direct current is the battery B-3. It is further to be observed that the primary winding of the telephone transformer P-7 is connected to each group of microphones through a condenser C-7 so that the speech current flowing through P-7 acting upon secondary S-8 contains no DC component but only the speech variation component.

If it is now desired to telegraph with undamped oscillations, the circuit from the DC source B to the coils E′ is closed. The strength of the excitation current is regulated by the resistance R to the desired degree of core saturation. If then the key K-4 is manipulated so as to cut resistance R-3 in and out of the circuit, the desired signals are produced by alternately tuning and detuning the alternator and antenna circuits in the way explained heretofore.

If at the same time the constants of the load circuit including the ballast R, are properly adjusted and the switch K-2 is closed, the load on the generator remains constant for it is automatically shifted from the artificial aerial to the antenna proper; that is, the constants of the circuit are so selected that when the antenna circuit including windings S-4 and S-3 is in resonance with the impressed radio frequency, the inductance of S-5 and S-6 is changed to throw the dummy circuits out of resonance and vice-versa. This tuning and detuning, may it be repeated, is accomplished by changes of flux through the iron cores. The provision of such means for maintaining a constant load on the generator is particularly essential in the use of high powers but in transmitters involving the use of small amounts of energy, satisfactory

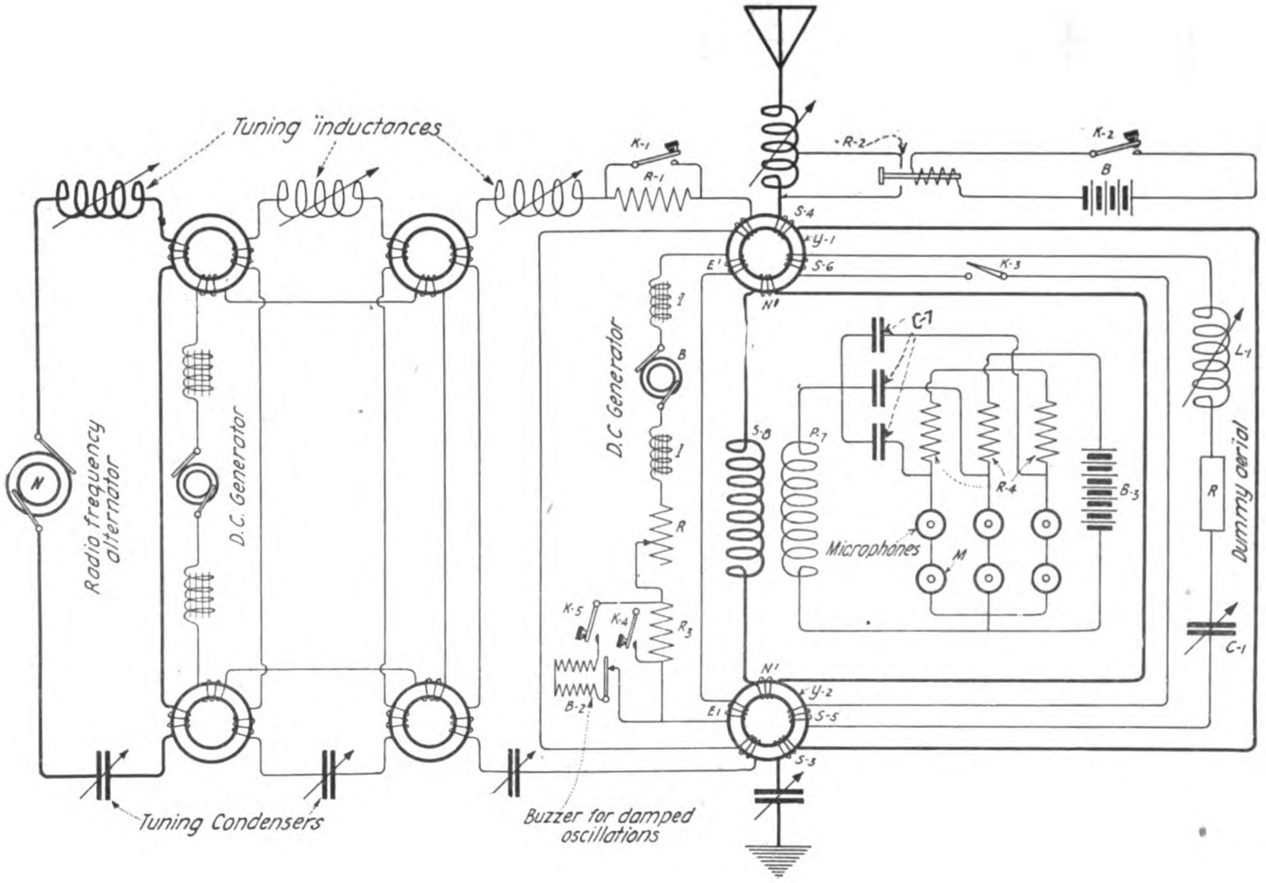


Figure 18—Frequency changer transmitting system for wireless telephony, or telegraphy by damped or undamped oscillations

signaling may be accomplished by opening and closing the keys K-1 and K-2 as described in the previous article. Moreover it is desirable to provide both means of signaling so that in case one becomes inoperative an alternative arrangement is available.

If it is desired to generate damped oscillations at an audio frequency, key K-5 is opened and closed causing the buzzer B-2 to be set in operation. The resulting variation of the excitation current through the coils E' through the operation of the buzzer, causes sufficient change of impedance in the radio frequency changers to vary greatly the antenna current. Thus the antenna will radiate oscillations which can be detected by detectors suitable to the translation of damped oscillations only. In place of the buzzer, alternating current may be superimposed on the winding E' to produce damped oscillations at audible frequencies.

THE CIRCUITS FOR WIRELESS TELEPHONY

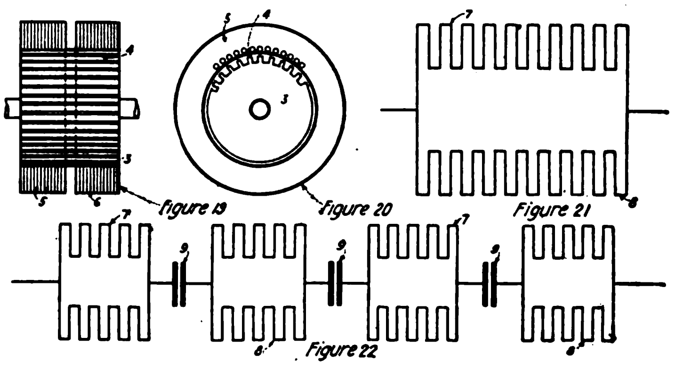
To use this apparatus for speech transmission, the resistance R is first adjusted to a suitable value, and then the microphones M, connected to the transformer P-7, S-8, are put into operation. R is adjusted to a critical point on the characteristic magnetization curve so that the speech currents through the primary P-7 set up similar currents in the secondary windings S-8 and the coils N, N. The resulting change in flux through the yokes Y-1 and Y-2 will cause a relatively great change in the strength of the antenna current.

A close survey of the microphone circuit will show that in each branch two microphones are connected in series but three branches are connected in parallel. Each of the three banks is fed from the source B-3, through their individual resistances R-4. Across each microphone is shunted the primary P-7 of the telephone transformer P-7, S-8 each branch including one of the condensers C-7.

The operation of the microphonic control is as follows: Whenever the microphone resistance increases, the current through its series resistance remains nearly constant, but the current through the microphone diminishes. The excess current resulting therefrom flows through the primary winding P-7 and the corresponding condenser.

REGARDING THE DESIGN OF THE RADIO FREQUENCY ALTERNATORS

After many experiments Arco and Meissner have found that a type of radio frequency alternator having an air gap the longitudinal axis of which has the direction of the axis of the rotor gives the greatest efficiency. This construction permits the use of a small air gap which is a matter of importance on account of the large number of field poles. It has the further advantage of increasing the output of the machine.



Figures 19, 20, 21, 22—Constructional details of the dynamo rotor

The rotor indicated at 3 in figures 19 and 20 consists of a toothed wheel without windings driven at a very high speed. The poles which are formed by the teeth are of equal polarity and the generation of radio frequency currents is secured by an undulation of flux and not by a reversal thereof which is the case of any ordinary alternator.

It has been found of particular advantage to divide the generator symmetrically in the middle at right-angles to the rotor axis so that equal stator halves 5 and 6 as in figure 19 are obtained.

The continous wave windings of the two winding halves 7 and 8 of figure 21 are preferably arranged in parallel so as to maintain the generator's self-induction and the generator voltage developed by resonance within the winding at a low value. This precaution is particularly necessary because on account of the large number of poles in high frequency generators it is difficult to insulate the armature windings.

In order to further reduce the difficulties of insulation due to high voltages, each stator half in generators of high power is divided into an equal number of sections and the two corresponding sections of the two armature halves are in each case arranged in parallel as a group as shown in figure 22.

The resulting groups are preferably arranged in series with condensers 9 placed between each group as indicated in the drawing. This arrangement reduces materially the equalizing currents which occur in the parallel arrangement of the armature halves, due to inequalities in the winding. Beyond this the maximum voltage between the entire winding and the stator is no greater than the voltage between an individual partial winding and the stator.

It is also advisable in the case of large energy outputs to provide means for conducting cooling water through the iron and stator. This has been provided for in the latest types of equipment.

VALVE ARRANGEMENTS OF THE RADIO FREQUENCY CHANGERS

Finally it may be mentioned that it is possible to use the well-known valve connections for the radio frequency changers shown in figure 23. They are symmetrically inserted into the four branches of a Wheatstone bridge. In the middle branch of the bridge of the group A, is inserted the primary winding of a transformer P acting on the secondary S the complete circuit of which is tuned to currents of double frequency. The current in S may be fed to a further group of radio frequency changers the secondaries of which are directly connected to the antenna.

As an alternative arrangement two of these mono-inductive resistances may be substituted by an induction coil from the middle of which a third conductor is branched off as shown in figure 24. Here the middle conductor P is connected to the middle of the armature winding of the generator 1. In this case the two remaining mono-inductive resistances or rather the windings A and B are arranged on one yoke, Y-1, which also carries the two direct current windings D-1 and D-2.

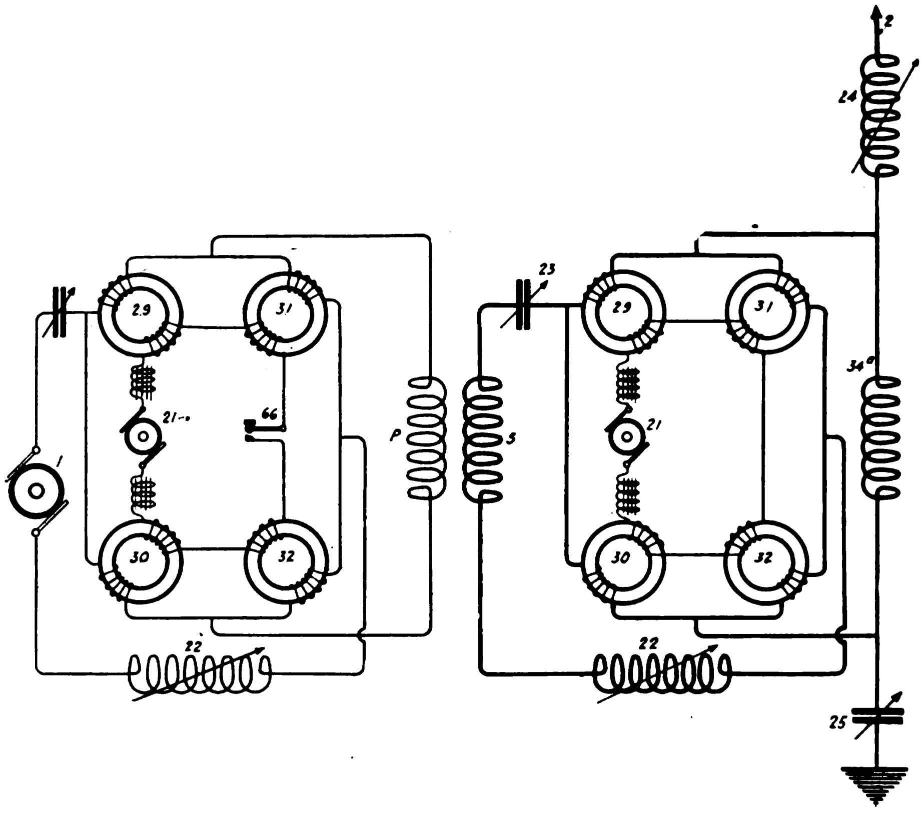


Figure 23—Valve connection of frequency changers

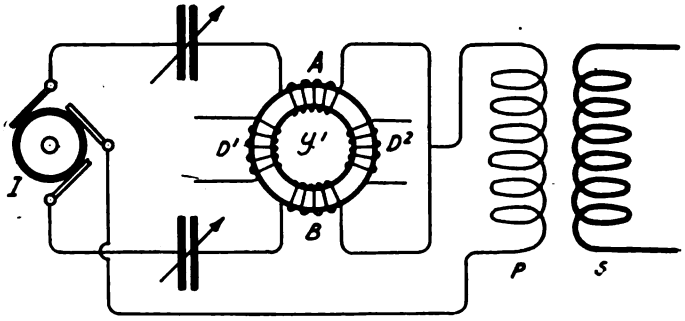


Figure 24—Alternative method of frequency doubling

The Monthly Service Bulletin of the NATIONAL WIRELESS ASSOCIATION

Founded to promote the best interests of radio communication among wireless amateurs in America

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In Memory of "9YA."

According to word received from the War Department, Lieut. Lyman (Pete) Case has been missing in action since August 14. Later advices report that he was in a bombing airplane squadron and met in collision with a German machine in the neighborhood of Metz. His airplane was seen to crash to the ground from an altitude of 12,000 feet.

Lieut. Lyman Case, reported missing in action, a former well-known N. W. A. member

Lieut. Case will be well remembered by members of the N. W. A. and other amateurs of the United States as the former operator of 9YA, of the State University of Iowa, Iowa City. He was one of the most able assistants in all of the national relay programs which were executed prior to the declaration of war. He could see the handwriting on the wall and knew that sooner or later the Government would need a great number of young men, skilled in the radio art, and devoted nearly all of his spare time in teaching everyone within signaling distance of 9YA, the wireless code. Regularly, he sent out baseball, football and boat race results by wireless. These bulletins were copied as far east as Pittsburgh.

Lieut. Case was born August 7, 1896, in Nokomis, Ill. His parents live in Lamoni, Iowa, one brother being Dr. M. W. Case of Davenport, Iowa. He was one of the first Iowa boys to enter the Officer's Training School at Fort Snelling, in May, 1917. While there, he volunteered for the Aviation Section, Signal Corps, and was sent to Toronto, Canada, in July. From there he was sent to Camp Borden, Texas, at which place, in November, he did his first flying. He was transferred to Garden City the 1st of January and sailed for England January 31. In Scotland, for several weeks Lieut. Case engaged in daily flying. He wrote numerous letters explaining how valuable his training as an amateur had been to him. He was later sent to France and was one of the American aviators who were organized with the Royal Flying Corps. It has not been possible to secure information as to where Lieut. Case was buried.

It will be appreciated if all the wireless amateurs of the country will join with the writer in sending letters of condolence to his family in their bereavement. Wm. H. Kirwan.

VICTORY!
Get Ready for Re-Opening of Stations

Washington, D. C.,
Dec. 14, 1918.

Wireless Press:

Hold up publication of "Age" for insertion of following notice:

To All Members:

From all indications the bill in Congress to blot out the amateur has failed. The amazing war record of American amateurs has been openly recognized before the Congressional Committee and an amendment to the bill has been introduced permitting amateur stations to reopen on approximately the same basis as before the war. The hearings on the bill will not close for some days, but it appears that the Government ownership proposals are doomed. Amateur communication will probably be resumed on conclusion of peace as before, under the present law, the act of August, 1912.

The victory is cause for mutual congratulation among all amateurs and best wishes to the field at large are extended for the new year.

Special Committee, N. W. A.
J. Andrew White,
Alonzo Fogal, Jr.,
E. E. Bucher,

Radio Station, 24 Balloon Co.
France.

The Editor, Wireless Age—Kindly publish this in your valuable magazine:

Radio men in the U. S. service "over there" are dying to receive your last month's Wireless Age. What do you say, old man? Send yours soon. The last one I saw over here was last March. Hoping to hear from someone in regard to this soon, I am Yours,

Joseph E. Engstrom,
Radio Station, 24 Balloon Co., A.E.F. Air Service.

Antenna, Radiation and Ground Resistance

I submit herewith a table prepared from actual tests showing the relation of antenna resistance, radiation resistance and ground resistance of a particular aerial over a change of wave length from 400 to 2,000 meters. The antenna had a capacity of .00126 microfarads, inductance of 43 microhenrys and a fundamental wave length of 440 meters.

Wave Length	Antenna Resistance	Radiation Resistance	Ground Resistance
400	26.0	14.0	6.5
500	19.0	9.0	7.5
600	16.0	6.7	9.0
700	14.9	4.9	10.1
800	15.0	3.5	12.0
900	15.8	3.0	13.5
1000	16.9	2.5	14.8
1100	18.0	2.0	16.0
1200	19.0	1.8	17.5
1300	20.2	1.7	19.0
1400	21.5	1.6	20.2
1500	22.5	1.5	21.9
1600	24.0	1.4	23.0
1700	25.5	1.3	24.6
1800	27.0	1.2	26.0
1900	28.4	1.1	27.8
2000	30.0	1.0	28.7

This table indicates that the ground resistance increases gradually for each increase in wave length, but the radiation and antenna resistance drop around 700 meters. The antenna resistance then increases again. The radiation resistance decreases gradually until the wave length of 1100 meters is reached, whereupon it decreases more slowly and at a more uniform rate. The most effective radiation would take place at wave lengths between 600 and 700 meters, with this particular aerial.—

E. T. Jones—*Louisiana.*

Protests With a Point

Evils of a Legislative Boomerang

THE bill, H. R. 13159, introduced by Congressman Alexander and referred to his committee, calls for outspoken protest from every amateur wireless man in the United States. Senate bill, S. 5036, which appears to be a duplicate, equally calls for vigorous opposition.

These bills make wireless an out-and-out Government monopoly. The Navy would, by the bills' provisions, come into possession and operation of the whole American radio communication system.

A provision is made for experiment and technical training school stations. No mention is made of amateur stations. That the omission was intentional is clear, because the present law distinctly classifies these as: general amateur stations, special amateur stations and restricted amateur stations.

Perhaps some genius might design an amateur station that would not transmit signals outside his state boundaries or receive outside signals—and be permitted to operate. But this is a ridiculous and valueless assumption. Yet that is the only opportunity the present bill offers. It frankly and unreservedly gives the Government permanent possession of radio and its unrestricted operation.

Two conclusions are reached by reading the Alexander bill. First, that the Navy expects by throwing the sop permitting experiment and technical schools to operate, to overcome the objections of leading scientists that experimental progress in an infant art would be killed off by Government monopoly. Second, that the Navy considers amateur wireless of no real or potential value, so purposes to wipe it out.

Against the opinion of the framers of this bill is arrayed a sizable body of serious students in the art, to which the Government is under great obligations. The officers of the National Wireless Association, with a membership of representative character and proportions, feel qualified to speak the unanimous sentiment of this great body of amateurs succinctly as follows:

The Alexander bill is a high-handed and unjustified attempt to trespass on the rights of American citizens and a legislative boomerang that will do incalculable damage to its undoubted exponents, the Navy itself.

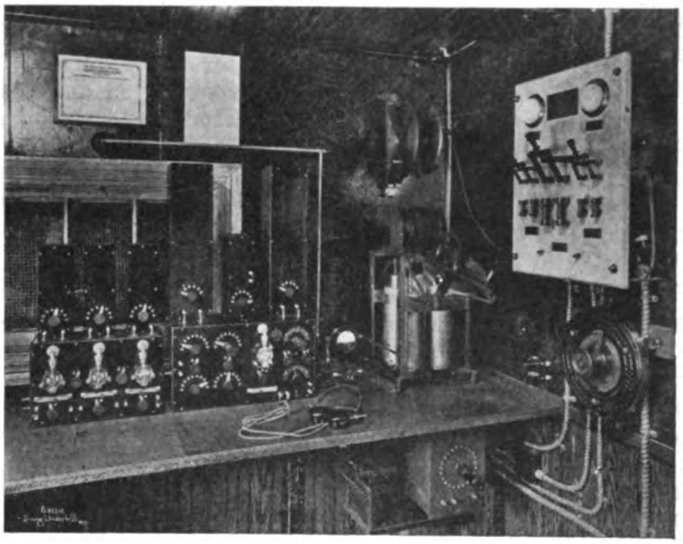
On behalf of its membership, the officers of the Association call for complete rejection of the provisions of H. R. 13159 and S. 5036, on the grounds that enactment will absolutely stifle amateur radio communication and thereby bring to a permanent end the development of an experimental group under which have been conducted activities of proved value to the nation.

President Wilson approves this measure, according to newspaper reports. The reasons for the alleged approval are not given. Wherefore it is inconceivable to amateur radio men that he has a true appreciation of the deliberate intention to end amateur work in wireless. The President's views on this subject are on record in this office. On March 1, 1916, he wrote to the Association an endorsement of its activities, the organization of amateurs in his opinion, being "undoubtedly a valuable asset to the nation." Further on the same subject, he wrote: "The value of such an organization in co-ordinating the activities of a large number of specially qualified young men along carefully planned lines will be of great benefit not only in an educational way to the young men themselves but also to the country at large when the necessity for their employment, individually or as an organization, may develop."

That is the substance of the letter. The necessity for employment which President Wilson anticipated, came a year later, in the emergency of war. And the amateurs made good—away beyond the most sanguine expectations.

In return for which service and fulfillment of promise, we are given to understand that their stations in which they prepared for the emergency, are to be permanently silenced and the pursuit of their studies in radio brought to an end!

Such an attitude is inconceivable from the world's leading exponent of freedom for all peoples. American amateurs will not be satisfied that the President's endorsement of the Alexander bill was given with the full understanding that it killed off amateur activities unless the proponents of the bill can introduce indisputable evidence to that effect.



Amateur Wireless Station Constructed by Alfred Henry Grebe

It is difficult also to recognize the obvious truth that the bill provides for the Navy to monopolize radio communication. Amateurs have been led to believe that the Navy looked upon them as useful. Captain Bullard, the first officer who administered the high office of directing naval radio communications, is on record, before the hearings in committee in January, 1917, with a statement that the amateurs should be left alone, that, to quote his exact words: "As far as the Navy is concerned, its activities are toward the uplift of the amateurs and not to destroy them in any way." Captain Bullard accepted honorary vice-presidency in this association, too, and in other ways indicated the sincerity of this viewpoint. His successor, Captain Todd, also in a letter to the Association, in October, 1916, protested against a member's view that proposed legislation "endangered our right to operate our wireless stations," stating this statement was ill-timed and misleading.

Secretary of the Navy Daniels also called in December, 1915, for the names and addresses of members, stating then that the need might arise in the Navy for many more men. It is an historical fact, now, that the need did arise and that the amateurs responded to the call.

In fact, during the war period, and preceding it, repeated requests were received for publication of appeals to secure the enlistment of amateurs, urgently needed for both Army and Navy.

Now that these amateurs have served their useful purpose, it is proposed that as a class they be exterminated. This presupposes a viewpoint that the emergency having passed, a future need will not arise. Blot out the amateur, therefore; he has served; cast him aside now.

It does not appear to enter into the question that the stimulus of wireless telegraphy as an art has a foundation and a source of personnel supply in those who begin their investigation by the home-study and experiment method. The provisions of the bill ignore the potential value of thus continuing to expand the field. It is sought, rather, that all future activity center about the radio establishment of the Government—that the development of a communication method still in a transitory state from an art to a science, be committed to the hands of a few workers on the Government payroll or in technical schools or professional laboratories. The individual worker, in a phrase, is to be suppressed. No opportunity is to be given for independent investigation and possible invention by the youth of the nation—in spite of the fact that the discovery of wireless telegraphy was made by Marconi when a boy just out of his 'teens!

The amateur of America is not typified, as many would like to have the lay public believe, by an irresponsible boy tinkering with tin-can apparatus in a backyard. As a class, the amateur is better represented by a number of commissioned Army and Navy officers called to the colors from civilian pursuits and engaged in designing administration work, and duties of the line of great responsibility. In all cases he is not wearing a uniform; but is serving also as inspector or expert radio aide. It follows, then, that the skill of these amateurs in radio is considerable. It is indisputable, also, that this skill was acquired over a long period of individual experimenting, not through the intensive training facilities offered by the Government in emergency.

The amateur who, for physical reasons or because of dependents, couldn't don olive drab or navy blue, has also served. A generous response followed the appeal to this Association to supply instructors for radio and buzzer operators, 20,000 being required by the Signal Corps. Men who volunteered for this work, conducted by the Federal Board for Vocational Education, included graduate electrical engineers, power plant superintendents and commercial wire chiefs—men in their early forties—and all amateurs in wireless.

As a further illustration of how the amateur was viewed by the military establishment, appeals were made to this Association for highly skilled men for the radio intelligence section, it being specifically stated that students in schools and beginners would not do. Men of the requisite qualifications were supplied from amateur ranks.

These special duties proved beyond question that in wartime the nation could not properly function in radio without men of experience. The experience dealt with in the instances cited is 100 per cent. amateur. Yet it is now proposed that the work of these men in radio be stopped short, that no more amateurs be developed or present ones be permitted to continue their experimental work!

A monopoly of the air, as this bill conceives it, is preposterous. No student of the radio art will concede that scientific development is feasible if left solely to employes of this Government, or any other. Nor does the cry of "interference" awaken any supporting response. It is in every way as ridiculous to forbid vehicular traffic on highways because Government business is being transported over them, as it is to forbid freedom of the air because of Government communication.

As a war measure, silencing and shutting down amateurs was right and proper. There was no protest. But in time of peace, such autocratic proceedings will meet with nation-wide protest.

The matter of so-called interference has been discussed at length many times. **The broad statement that what little interference existed was caused by improper adjustment of receivers and transmitters and poor operation, covers the whole argument. The present law provides, by fine and revocation of license, adequate protection from this annoyance, which, as a matter of fact, exists in infinitesimal quantity.**

It will probably be argued that amateur wireless must be killed off so secrecy may be maintained. Technical advancements insure the reduction of unintentional eavesdropping to an unimportant minimum. The present law provides fine and imprisonment for divulging the contents of a message. What more can be accomplished? Deliberate interception of wireless messages can be carried on secretly no matter what restrictions the law may provide.

It is impossible to insure entire secrecy in any field of communication. All wireless messages in transmission are not easily available to any who care to listen. And it is wholly unfair to the radio art to deliberately foster that opinion in the public mind. The true situation is simply this: Telephone, telegraph and cable lines can be tapped just as readily as wireless can be intercepted. The party-line telephone and the telegraph sounder exactly illustrate the conditions.

Pertinent to the subject of wilfully disclosing the contents of messages, there is another consideration. If the Alexander bill becomes a law 100 per cent. of the radio communications of commerce are placed in the hands of naval operators. These men are citizens of the United States and of course subject to its laws. Should the inference be drawn that they are less susceptible to temptation in disclosing commercial secrets than are other citizens—the amateurs? There are laws against crime, but crime is committed. Is it a fair assumption that Government employes are immune, and the only potential lawbreakers are private citizens?

The matter of secrecy appears from any angle, unimportant, if not irrelevant, in a discussion of reasons for legislating the amateur out of existence.

While not a single valid reason appears why the amateur field should be wiped out, it is clearly demonstrable that the attainments of these individual workers are an appreciable contribution.

Prior to the war the advances in radio which were contributed by Navy men were negligible. All improvements of basic character originated entirely outside the Governmental establishment. The naval achievements consist entirely of detailed variations in

design of apparatus to suit military needs. Wartime improvements are another matter entirely; the amateurs, scientists and commercial engineers and the Government experts all became a unit working to a common end. Whatever developments followed only serve to emphasize the importance of the civilian radio man. Thus the contributions to the art from Government sources must stand examination on progress before the war. And, it is repeated, not a single basic achievement can be presented, whereas the broad field of experimental workers, by invention, incontestably builded the art to a highly efficient state.

The assumption that with Government ownership in force, a hand-picked personnel of experts can be drawn into the ranks of official radio will not stand the test. There is no profit in inventing where there is federal domination, comparable to the reward which commercial industry offers. There is no future for the amateur in production engineering where commercial companies will have but one customer, the U. S. Government, and prices thus become arbitrary. Patents will have a solely speculative value because the Government uses any invention it requires—and refers the inventor to the Court of Claims to await its award, if any.

Naturally, the experimental field will dwindle down to minute proportions. And the United States—the promoter of freedom—will face the sad spectacle of having repressed by official action a great body of earnest, thinking young men from continuing a self-determined course of educational study. It cannot be argued that this form of education will be adequately provided for by technical institutions of learning. The incentive to gain having been removed, or woefully restricted, professions other than radio engineering will appear vastly more enticing to the student.

It is a fact that in the senior engineering class at the Columbia University, at the outbreak of the war, 50 per cent. of the student body were former radio amateurs. Their amateur work had induced them to follow electrical engineering as an eventual profession.

All educational institutions are required to appeal for students; they must be attracted; they do not come to the higher halls of learning unless they are encouraged. And it is submitted that amateur wireless is an extremely valuable means of introduction to the study of electrical science.

The demolition of the amateur field in radio with one legislative blow is a serious matter. As near as can be ascertained there were, prior to the war, 175,000 amateurs in the United States. The figures are based upon the sales records of manufacturers of electrical supplies which show that the purchases of receiving equipment were about in the proportion of 25 receivers to 1 transmitter. Transmitting stations only requiring licenses, and 7,000 of these having been issued, it is evident that the total in round numbers represents 175,000 amateurs. Since these stations will show a fair average investment of $50 each, there is an aggregate investment involved of something like eight and three-quarter million dollars.

But that sizable sum of money represents more than a loss in dollars and cents. The assembly of these stations necessitated a stupendous amount of labor. And with this labor came a still greater acquirement of technical knowledge—that expensive commodity, education—gained by first hand familiarity in assembling and constructing intricate electrical devices.

Is it to be abandoned by a non-advantageous legislative act? Can the future of the existing amateur field be cut off short without due consideration of its claims of valuable achievement?

In the war just ended, amateur wireless saved the Government several million dollars. It has been established that the cost of training men for military service in radio was about $1,000 per man. In the case of the amateur the training period was materially shortened, the per capita cost being reduced perhaps two-thirds. And it is also of interest that the total facilities available in universities and technical schools could provide for but 150,000 men. The existing amateur field was larger by 25,000.

Utility is another consideration worthy of note. The achievement of Mr. Apgar, an amateur, in disclosing to the Department of Justice the unneutral messages sent out by the Sayville station—resulting in its seizure—calls for recognition. It has never been denied that Texas and California amateurs detected the same type of communication over the Mexican border. Nor can the credit be placed anywhere but in the amateur's hands for the maintenance of communication during the floods in the Middle West in 1914 and 1915. It is indisputable also that an amateur saved the situation in Hamilton, Ohio, in 1913. During that flood Mr. Swain, an amateur, was the only man available for communication. He connected up a key and sounder and supplied the only means of communication from the east side of the city, thus securing food, clothing and other supplies urgently needed. Mr. Swain's interest in amateur wireless qualified him to accomplish the feat. The work in flooded districts did not end there. Up to the date of our entry into the war, the station of the Doron brothers in the same city was employed in reporting the stages of river rise whenever the possibility of a flood was imminent. Throughout the entire country drained by the Miami River this station was regularly consulted for reports whenever the river began to rise.

Amateur wireless has a distinctly recognized place in agricultural areas also. Regular distribution of weather reports has been a voluntary service rendered in outlying districts where six to twenty-four hours are required for the mail to arrive from the nearest office of the Weather Bureau. That farming districts require and appreciate this service of amateurs needs no further comment when one reflects upon the problematical value of reports arriving by mail six to twenty-four hours after issuance.

It is also well known that nearly every big ranch in the West had its amateur station for the same reason.

In summary, therefore, it is contended that irreparable damage will be done to the interests of the nation at large if the Alexander bill becomes a law. It is also advanced that the radio art will stagnate under a policy of Government ownership and imperialistic domination of radio communication with all powers vested in a department organized basically for making war.

This Association knows that it voices the full sentiments of the amateurs of the United States in expressing this protest. Thousands of amateurs are still in uniform and are thus effectively silenced. But the protest is supported by the large majority of these patriots also, the Association is confident, for many have been consulted and the desire for permitting amateur radio communication to re-open under the present law (the Act of August 13, 1912) has been unanimously expressed.

NATIONAL WIRELESS ASSOCIATION,
J. Andrew White,
Acting President.

Some Technical Aspects of Government Wireless Ownership

A FAVORED argument of the proponents of Government ownership to enlist legislative support is the assumption that because a wireless telegram has no guiding wire but employs the all-pervading ether as a conducting medium, it is entirely beyond the control of the sender; therefore it will set up interference to the operation of other stations. The impression is fostered that such messages find their way into the apparatus of stations for which they are not intended, setting up a veritable bedlam which nothing but Government ownership can still. Only through Government proprietorship, the argument continues, can these cross currents be prevented, because federal authorities can then dictate to the last detail the daily operation and acts of every radio station in the nation.

To the lay mind these statements may be impressive, but they fail in the true light of the engineering facts. The ether carries myriads of vibrations simultaneously without interference. It is generally accepted today by leading scientists that heat, light, X-rays and the electric waves of wireless telegraphy are nothing more than different rates of vibration of the ether. The radio engineer may select one of several thousand rates of vibration and employ his choice in communicating between a given set of stations without interfering with the operation of other stations. It should be made clear that the frequency of vibration of the wave motion sent out by a wireless transmitter has a certain definite value, and the receiving instrument must be adjusted or tuned for exactly the same rate of vibration in order that communication may be established.

This is exactly the method by which mutual interference between wireless stations is prevented. There is no reason to believe that the Government radio men are better qualified for selecting and using frequencies of vibration than are the experts of commercial or amateur radio.

There is no objection to Government regulation and supervision, but there are innumerable objections to sole Government ownership. Under the existing laws, Government, commercial and amateur stations are provided with standard wave lengths, which in themselves eliminate the basic problems of interference. Everyday wireless operation has demonstrated that by wisely selecting the wave lengths to be employed, hundreds upon hundreds of wireless stations may be operated without any interference whatsoever.

Before enacting any drastic statutes eliminating the amateur from the program, Congress should investigate and value the benefits which our Government derived in the recent war from the services of the amateur wireless operator. It should be known that experimentation in this art is the best promoter of scientific education of the day. The degree of skill required to operate wireless apparatus should be appreciated, as well as the value of the amateurs' experience in continuing the art of wireless telegraphy through the past few years.

A second so-called argument advanced by Government ownership advocates, is that the amateur wireless operator can, if he chooses, copy down commercial and Government messages, thereby coming into possession of confidential communications which might be employed in a harmful manner.

It is this committee's purpose to prove that the amateur wireless experimenter, obeying existing laws, will not interfere with official or commercial message traffic.

The pre-war regulations were sufficiently stringent to meet all technical requirements for the prevention of interference. Under the existing law amateur wireless transmitting sets are restricted to the wave length of 200 meters, and power input of one-half kilowatt for stations within five miles of a Government station, and to one kilowatt for stations outside a prescribed zone. A further requirement is that the decrement of the radiated wave be no greater than 0.2 per complete cycle, the latter being a precaution to ensure a sharp wave, thus decreasing the possibility of interference or cross currents at any Government receiving station.

The greater proportion of official and commercial communications are dispatched at wave lengths above 600 meters. Certain stations are operated at lower wave lengths—down to 300 meters—but since electric wave radiation at the shorter wave lengths has not proven as effective as at 600 meters and above, the use is not general.

Receiving apparatus at Government stations is ordinarily tuned to wave lengths of 600 meters or greater; the amateur operates on a wave length of 200 meters. With the improvements that have been effected in wireless transmitting and receiving apparatus during the past few years, the possibility of experimental stations interfering with the operation of Government stations is so small that it is negligible.

This committee's contentions are based on the following facts:

It is a comparatively simple matter to design an amateur transmitting set to radiate waves with a decrement as low as .05 per complete cycle. Add to this sharpness of radiation the selectivity obtainable with modern vacuum tube detectors and associated circuits, and it will be found that between stations with wave lengths having the 400 meter difference between 200 and 600 meters (or even a lesser difference) the possibility of interference is reduced to a minimum.

Two types of receiving circuits have recently been developed that further reduce interference at the receiving station:—the **regenerative beat receiver** and the **cascade radio frequency amplifier.** Either system installed in a Government station will eliminate cross currents. In fact, the selectivity of the cascade circuit is so fine that it requires very precise adjustment on the part of the receiving operator to pick out the desired signal.

If, under all circumstances, it is necessary that amateur transmitting stations comply in every detail with the law in respect to the sharpness and purity of the wave radiated from transmitters, no complaint, then, can arise from Government stations. With a pure wave emission a one-half kilowatt amateur station may be operated within a mile of a Government station equipped with modern receiving apparatus of the type aforementioned and not cause the slightest interference. To insure this freedom from interference it is only necessary for the Government to exercise its authority under the present law; viz., see to it that the amateur station radiates a pure wave.

In support of the statement that a 200 meter amateur station will not interfere with the operation of Government stations, is an exact knowledge of radio engineering principles and a series of actual tests made under practical conditions. It follows that if a Government station is interfered with by a 200 meter amateur transmitting set, the apparatus at the Government station is poorly designed or improperly handled.

It must be admitted that the damped wave spark transmitter adjusted for low decrements afford sharpness of tuning nearly equal to continuous wave generators, but if the decrement of the spark transmitter is still employed as an argument, the amateur may resort to more modern types of undamped wave transmitters, thereby removing the last vestige of justifiable complaint about interference.

Greatly improved apparatus has been developed during the war. The vacuum tube transmitting set, for example, has been highly perfected and is one which amateurs may employ to the greatest advantage. It is possible to operate these transmitters at the wave length of 200 meters with a power output of a fractional amount of a kilowatt of energy. Because with such transmitters genuine undamped waves will be radiated, the factor of selectivity will be vastly increased over the old type of transmitter, removing to the lowest degree the possibility of setting up interference with a Government station. It is unquestioned that vacuum tube transmitters will be adopted by amateur experimenters in increasing numbers and within a short time pre-war types of spark transmitters will be in minority use.

The United States Government already has had through previous legislation control of the operation of amateur wireless stations. In the event that any of them did not comply with the law they were reported and the regulations were enforced by the Government's local inspector operating under the Department of Commerce. Violations of the law in pre-war times were limited to a few instances, and were entirely unintentional. A reminder from the Government inspector proved sufficient to place the offending experimenter on the straight and narrow path. There is no reason to believe that the amateur will in the future get out of the control of the Government authorities.

Now, on the subject of a supposed second argument: What possible harm can be occasioned by the presence of the amateur eavesdropper? What confidential information would he by chance be likely to hear in carrying on his experimental work? A few Government orders, many commercial messages and ship position reports! But he is already enjoined by Government legislation from divulging the contents of such communications, and any one whose interests might be injured by his disclosures would have full recourse to the courts of law for damages. To the best of this committee's knowledge, not a single instance of the kind occurred during five years of regulated amateur operation.

It does not appear that there is any danger to business interests through the reception of messages by the eavesdropper; business men do not send confidential communications in plain English over the telephone, cable or wireless. It cannot be said that the wires or cables are strictly secret and it should be known that long distance wireless telegraphy in the immediate future will be conducted at speeds of 200 words or more per minute. Apparatus has already been perfected that will permit such rapid transmission and reception. Ear reception is limited to 30 or 40 words per minute. So the amateur has little chance of ascertaining the contents of high speed messages, unless he is provided with a mechanically elaborate—very costly—high speed recorder capable of taking down these signals.

With long distance radio communication carried on at 200 words per minute and important business messages from ship to shore or shore to ship transmitted in cipher or code, about the only messages that the eavesdropper will be likely to hear would be somewhat to this effect:

MARY SMITH, ALTOONA: SHIP DOCKS AT TEN O'CLOCK. MEET ME.—JOHN.

Inadvertent disclosure of the contents of such a communication would be somewhat analogous to the immensely harmful practice of country postmasters reading incoming postcards.

What benefits would a Government monopoly give to the nation at large? None whatsoever. It would invest the powers of control in the hands of a favored few. It would destroy all incentive for the inventive genius of our country to conduct research towards improvement of wireless communication. Forfeited would be the hundred-and-one commercial applications of the art which would naturally follow under private ownership and freedom of operation. It would give the Government the power to say, "thus far and no further." The advance of the individual would not rest on merit, but upon bureaucratic favoritism. It would destroy the enthusiasm characteristic of American enterprise to develop a new art. It would completely wipe out a branch of experimentation that has done more to further the interests of technical education than any other discovery heretofore made. Such a procedure on the part of our Government is utterly un-American and contrary to all precedent.

Who is responsible for the great inventions in wireless telegraphy in the United States? Surely they cannot be credited to Government initiative. Who, it may well be asked, perfected the Radio Frequency Alternator, the Poulsen Arc Generator, the Vacuum Tube Transmitter, the Regenerative Beat Receiver, the Vacuum Tube Wireless Telephone Transmitter, the Direction Finder, the Weagant Static Eliminator, and numerous other appliances which have advanced the art in the past few years? Every single one of these inventions were perfected by private citizens. Many of these men were former amateurs, and in many cases it was the observations of these men as amateurs which spurred them on to make deeper investigations resulting in the solution of some difficult scientific problem. Who knows but that some amateur wireless experimenter will bring forth a new idea that will revolutionize the art?

Of all the inventions of the past half century, none has created such universal interest as wireless telegraphy. Resulting experiments have been of immense benefit to mankind because they have tended to promote technical education, a matter of paramount importance to America's industrial future.

Amateur radio operation requires a study of fundamental principles of electricity. An insight into the electrical and mechanical sciences is thus gained that most likely would not be induced by any other line of experimentation. It has been demonstrated that the amateur's keenness in manipulating wireless telegraphy equipment was of untold benefit to the Government in the recent war. Through his experience the amateur relieved the Government instructor of a great deal of unnecessary delay in training enlisted men to operate the Government's wireless apparatus.

We have shown ourselves to be a resourceful nation in the event of a national crisis such as arose in the recent war. Our shops, our laboratories, colleges and universities were turned into a united war machine to carry out the plans of the military establishment. Where would we have stood had not the amateur experimenter and the scientist responded so whole-heartedly to the call? Whatever argument may be presented that the amateur's small wireless station might prove detrimental to our peace-time naval and military program, fails before the more forceful one that a small army of amateur wireless operators will again be of inestimable advantage in possible future emergencies. The amateur wireless experimenter should be left alone. Our country may be only too glad to utilize his services at a most unexpected moment.

TECHNICAL COMMITTEE, N.W.A.

A Plea for the Radio Amateur

IT is greatly to be hoped and urgently to be desired that the bill now pending in Congress for the control of radio communication during peace times, and tending to prohibit amateur wireless communication, should be defeated.

No government created the art of radio communication. The art and science of radio communication were both brought into existence by the efforts of amateurs, amateur electricians and physicists. It ill-becomes representatives of a government like ours that they should seek now to confiscate from the amateurs of the country that facility which amateurs produced.

The right to use the air we breathe for talking by sound-waves is unchallenged to all citizens of our globe. Why should the right to talk through the air by invisible electro-magnetic moves be denied!

Everyone will agree that when an amateur abuses his privilege of free speech by radio, through the ether, so as to interfere objectionably with the rights of others, the offending amateur should be proceeded against according to law; but within the proper limits, the amateur should be encouraged and aided by the government, not discouraged and repressed. During the last fifteen years, a number of improvements in radio communication have come about through the enthusiasm and studies of amateur radio operators. Now that the government is able to utilize these improvements, the proponents of this bill will seek to confiscate them, to the exclusion of all future amateurs.

The privilege of listening in, and also, within reasonable limits, of joining in the world's conversation through the all-pervading ether is a godsend to our race and time. No one but an amateur, or person who has practiced radio communication, can fully appreciate the magnitude of that privilege—the opportunity of listening in succession to all the multitude of messages borne upon the ocean of electromagnetic waves. **To destroy that privilege would be one of the most cruel acts of history, worthy only of the Bolsheviki.** During war time, there has been no noticeable complaint on the part of the amateurs of the country, at being debarred from use of the radio apparatus that, in many cases, they had built up with great pains by their own hands. Now that peace is being restored, it should be allowed to restore its blessings to the radio amateur.

The cultivating and civilizing influence on all our people, especially our young amateurs, of putting themselves into intellectual communion with fellow radio telegraphists all over the world, is a great asset to the country. The privilege of entering into the great electromagnetic ocean of intellectual exchange is of the greatest educative value. Anyone who has enjoyed the installation and operation of an amateur radio station, knows that this is a free education in itself. It is an occupation that not only develops the soul of the individual by giving him an insight into the mysteries of electromagnetics and the mysteries of long-distance transmission of ideas; but also tends to make him or her a more useful individual by becoming conversant with the international code of Morse signals. During the war we have trained, at great expense, thousands of young men to become operators, in order to perform more usefully the military tasks assigned to them. This training in signaling will be, also, of great value to those who have acquired it, in times of peace. By excluding the radio amateur from his natural rights and privileges as a dweller in the universal atmosphere, a relatively large number of self-trained Morse operators will be lost.

Radio communication is still a very young art, although it has been developing by leaps and bounds. There is an enormous amount of work yet to be done, in order to perfect and simplify the art of radio communication by telegraph and telephone. Every encouragement should be offered to all the young amateurs throughout the world to help in this development work. If they are excluded by force of government authority, the work of development will be confined to a mere handful of government selected men. Even on the assumption that the best men are employed in the selected group, it is evident that with the aid of all the amateurs in addition, they will be able to accomplish much more.

The great boon of radio communication should be left, as far as possible, free to all, under suitable legal restrictions against abuse of the privilege. Only in that way will inventors be stimulated to work at the various problems presented by the art. If the entire business of radio communication is vested in the hands of the government, the market for the sale of improvements by the work of inventors will be so restricted that very few will have the courage to persevere.

Experience during the recent war has abundantly shown that there will be no difficulty in the immediate acquisition by the military authorities of all the radio plants of the country, amateur or professional, when the emergency arises. Because, for that reason, the government is properly entitled to lay its hands upon all radio communication in war, it owes to the public the right of free communication in times of peace.

A world in which the voice of the radio amateur is hushed by the power of the law, and in which no one has the right to speech except the army or the navy, would be a world no longer free.

A. E. KENNELLY, Sc.D., A.M.,
Vice-President, N. W. A.,
Professor of Electrical Engineering,
Massachusetts Institute of Technology.
Past President, Institute of Radio Engineers.
Past President, American Institute of Electrical Engineers,
Former Principal Electrical Assistant to Thomas A. Edison.

Radio Amateur Work as a Scientific Mind Builder

PRESUMABLY the chief reason why men no longer burrow holes in the sides of hills to serve as their permanent residences is because it is one of the finer human traits to question and experiment. To make a shelter out of boughs proves the possession not only of a spirit of inquiry as to the possibility of improving on the muddy cave, but also a marked tendency to try something which may turn out to be a real improvement.

One of the most personally pleasant survivals of the cave man's attitude to question and try is the experimental attitude of the modern radio amateur.

Presumably (and fortunately) there never has been an amateur who was not a human question mark, or who was ever satisfied with his knowledge of what was going on in the apparatus used by him. The continual series of changes made by the up-to-date amateur show how alive he has been and also his need for verifying experimentally any point concerning which he is in doubt.

Since a questioning and experimental attitude is a real national asset, particularly in a free nation like ours, it is encouraging to note how widely the activities of the amateur have spread. An occasional word of caution is necessary, however. To question even thoroughly demonstrated facts is destructive. To change and experiment with equipment until all its usefulness is destroyed is absurd. The amount of experimental work carried out by the amateur necessarily should be limited by his discreet and reasonable use of apparatus and by the guard which he must set on himself in avoiding interference with other amateurs. Above all, he must bear in mind the grimly serious nature of the traffic handled by commercial and governmental stations, and use every means to avoid interfering, for his pleasure, with what is in their case a life-and-death or, at least, a bread-and-butter matter.

There is a personal aspect of the work of the amateur which has considerable attractiveness. Chatting with one's friends by radio certainly promotes a sort of broad neighborliness. A man's point of view cannot fail to be broadened by having in his circle of acquaintances a number of equally enthusiastic amateurs, centered not only in neighboring towns but even in adjacent states or further. The "small town" attitude melts away at the touch of the radio key and the amateur's world broadens out with the increasing range of his transmitter.

On the other hand, this increased range of the amateur may, and unfortunately sometimes does, bring him within the ken of commercial receiving stations in his neighborhood. A proper amateur code of ethics will at once prompt him to reduce power rather than to risk interference with important commercial or governmental messages.

America has always been proud of Yankee ingenuity and manual skill. Dexterous handling is surely fostered by radio experiments. Aside from the delicate and accurate touch on the key required for careful sending, there is a great amount of delicate adjustment of couplings, of variable condensers, of crystal points, and similar equipment. All of these help toward the development of the observing eye and a careful and dependable hand. The amateur develops a pride in the neat workmanship and excellent finish of his set and in its careful lay-out and business-like appearance. He develops ingenuity in meeting unusual experimental difficulties, in improvising new equipment even out of discarded odds and ends. Such resourcefulness is well worth while.

The amateur may purposely or inadvertently become a listener-in on private communications from ship to shore. This unusual privilege obviously carries with it a proper obligation to maintain a generously co-operative spirit, calling for the exercise of proper caution that there be no interruption of this traffic or annoyance caused to its dispatchers. It is a grave question whether indiscriminate listening-in to private communications will last indefinitely. High speed or code transmission may play a part in the communication of the future.

The amateur of the United States will therefore do well to raise the standard of what may be called his "profession" by joining the leading engineering institute in the field and affiliating himself with local amateur socities as well. He will thus keep in touch with all modern improvements and through the medium of the higher grade radio magazines, know exactly what is going on. In this way he will not lag behind the times, nor unconsciously cause trouble to the commercial stations.

We may hope under these conditions to have a steady stream of radio engineering recruits drawn from the ranks of the amateur with a resulting advantage to the entire field.

Alfred N. Goldsmith, Ph.D.,
Vice-President, N. W. A.

Director of Radiotelegraphic and Radiotelephonic Laboratory, College of the City of New York;
Editor, Proceedings of the Institute of Radio Engineers.

From the American Radio Relay League

A VERY serious situation has arisen. Unless all of us amateurs act quickly, a law will be passed in Washington which will wipe amateur wireless completely out.

I know you will find this hard to believe, **BUT IT IS SO.** A bill has been introduced in both the House and the Senate which may prohibit amateur wireless. It is **GOVERNMENT OWNERSHIP APPLIED EVEN TO OUR AMATEUR WIRELESS,** and whoever introduced it is guilty of gross lack of appreciation of the patriotism of those amateurs who, not waiting to be drafted, **VOLUNTEERED** in those first dangerous days of unpreparedness when our Army and Navy were in desperate need of young men who knew wireless. Not only are these young men ignored, but the bill is likely to be pushed through while they are absent in their country's service and rendered mute by military regulations, and forbidden to appeal on their own behalf.

Our American Radio Relay League officers are fighting hard, but we are only a handful. Alone, we cannot make the Congressmen in Washington appreciate the importance of amateur wireless. You must help us. You positively must write a letter immediately, and see that it is mailed before the sun goes down tonight to your Representative and also your Senator in Congress. You should say something like this:

> We protest against the injury that will be done many young men of this country if House Bill 13159 and Senate Bill 5036, which may prohibit amateur wireless, are passed without a full and free hearing. It will take time for the amateurs to present their case because most of them are in the Army or Navy and away from home. The Bills should be held up until the amateurs can be informed of what threatens them.

If you do not know the name and address of your Representative or Senator, your Postmaster will tell you. You must help, and today, or good-bye to all amateur wireless and the valuable experience and education that comes with it. Who knows but what a future Edison, Westinghouse or Marconi is in the making in your very house if he is allowed to continue his amateur wireless work.

THE AMERICAN RADIO RELAY LEAGUE, INC.
Hiram Percy Maxim,
President.

The Amateur as an Army and Navy Expert

YOUR attention is seriously called to a bill, H. R. 13159, "To further regulate radio communication," introduced by Mr. Alexander on Nov. 21, 1918, which was referred to the Committee on the Merchant Marine and Fisheries.

From articles which have appeared in the press, this bill was interpreted by many concerned to merely give the Secretary of the Navy the power to operate or maintain all commercial radio stations on land or on permanently moored vessels now in existence within the jurisdiction of the United States or any of its possessions, and that the commonly-called **"radio amateur"** would still be allowed to erect, maintain or operate for experimental and private use a radio station—if properly licensed, as provided by the Act to Regulate Radio Communication, approved August 13, 1912.

A glance at an official copy of Mr. Alexander's bill shows that the **"radio amateur"** was not even mentioned.

In the Act of 1912 a distinction was made between different classes of land stations as follows:

(1) Public Service Station (a) general (b) limited.
(2) Limited Commercial Stations.
(3) Experimental Stations for the development of radio communication.
(4) Technical and Training School Stations.
(5) General Amateur Stations.
(6) Special Amateur Stations.
(7) Restricted Amateur Stations.

On the present bill, H. R. 13159, the amateur station is ignored. Evidently Mr. Alexander does not know the important part which the "radio amateurs" have played in the war for democracy.

After the United States declared war on Germany our Government sent out a call for several thousand **trained radio operators** which were needed at once in various branches of the Army and the Navy. The result was that more than five thousand radio **amateurs,** skilled in the operation of modern radio apparatus, enlisted or accepted civilian positions in the Army or the Navy.

If Mr. Alexander had excluded the radio amateur from his bill of 1912, this radio personnel would not have been available for the great emergency. Dependable radio operators and radio experts capable of operating and erecting modern complicated radio apparatus cannot be trained over night; their skill rested on years of constant study and experimenting.

Statistics compiled two years ago showed that there were over 100,000 radio **amateurs** in the United States, not taking into account the boys and others who were merely playing with radio. Amateurs, as they are called, are the real experts, for they work at wireless for the love of it; they are building new apparatus all the time, experimenting with improvements in materials and in methods, spending the greater portion of their leisure time at the work. They are the enthusiasts.

It was a New York amateur, Edwin Howard Armstrong, president of the Radio Club of America, who invented the regenerative action of the vacuum tube detector which has made possible many recent evolutions in the radio art. Mr. Armstrong is now a Captain in the Signal Corps, U. S. Army, and has been in France for over a year as radio expert.

Below is a list of a few New York radio AMATEURS who have been in the U. S. Government service since we declared war on Germany, stationed in Washington, helping to solve the many radio problems from their knowledge obtained through experimenting with their own home-made amateur apparatus:

Mr. T. Johnson, Jr., Expert Radio Aide in charge of Aircraft Radio, U. S. Navy.

Lieut. H. Sadenwater, U. S. Navy, Radio Officer, Aircraft Radio.

Lieut. W. S. Lemmon, U. S. Navy, Radio Officer, General Radio.

Mr. B. R. Cummings, Expert Radio Aide, General Radio, U. S. Navy.

Mr. F. W. L. Horle, Expert Radio Aide, General Radio, U. S. Navy.

Mr. T. A. Hart, Expert Radio Aide, General Radio, U. S. Navy.

Mr. A. Allen, Expert Radio Aide, General Radio, U. S. Navy.

Mr. L. Spangerberg, Radio Inspector, Aircraft Radio, U. S. Navy.

Mr. J. A. Fried, Chief Radio Draftsman, Radio Division, U. S. Navy.

Ensign T. J. Styles, U. S. Navy, Aircraft Radio.

Capt. D. C. McCoy, Radio Officer, Division of Military Aeronautics.

Mr. J. O. Smith, Radio Expert, Division of Military Aeronautics.

With restrictions under the existing law of 1912, and using modern apparatus of the continuous wave type, the radio amateur cannot cause interference with naval stations. In my estimation, instead of eliminating the amateur, he should be encouraged to experiment more than ever, so that if the emergency should again arise, the Government will have at its disposal many thousand radio stations needed on airplanes, tanks, balloons, warships, torpedo boats, troopships, land stations ot any type, etc.

If this bill becomes a law, it means that the "radio amateur" will be completely ignored and only "scientists" will be allowed to experiment with radio apparatus of any description—receiving stations included. By a scientist, I mean a professor, or highly technical engineer, actually considered such by the Secretary of the Navy.

You are requested to take immediate action against the approval of this bill without an amendment authorizing the "radio amateur" to operate or maintain a radio station for experimental purposes.

LOUIS GERARD PACENT,
Radio Club of America.

Genuine Preparedness

THE lamentable unpreparedness of our country at the time of entering the war was complete in every respect but one—radio operators. The immediate response of some twenty-five odd thousand amateurs, trained to the minute in radio operation, was the one conspicuous exception to our otherwise total unreadiness. It seems unbelievable that the Government would countenance the loss of thousands of men in constant training for one of the most important branches of warfare, as would result by the passage of the Alexander bill in its present form.

Let the Amateur still be under the regulation of the Government as in the past, and this army of specialists will be ready day and night for the country's call.

H. E. RAWSON,
Station 7ZR, Rawson Ranches,
Kuna, Idaho.

Unjust Legislation

THERE is now pending before the House a Bill, H. R. 13159, proposed by Mr. Alexander to "Further Regulate Radio Communication."

I would strongly urge your opposition to the passage of this bill, as it aims to suppress the development of radio communication by private individuals.

Among the many reasons why the "radio amateur" should be encouraged rather than suppress, are the following:

Immediately after our entry into the war, FIVE THOUSAND RADIO AMATEURS placed themselves at the disposal of the Military and Civil Departments of the Government. This would have been entirely impossible were it not for the fact that, before the war, there were many thousands of radio amateurs experimenting and maintaining their own stations, built by themselves and used for developing the art. Moreover, the present high stage of development is largely due to the efforts of radio amateurs. Preeminently among these is Mr. Edwin H. Armstrong, who through the development of the oscillating audion made possible the practical use of long distance communication and the possibility of directing, by means of the radiotelephone, Aircraft in battle.

Many high positions are now held in the Military and Civil Governmental Departments by men who just recently were radio amateurs.

Any legislation which ignores the radio amateur is fundamentally unjust and should be relentlessly opposed.

A. H. Grebe.

QRM from Washington

THE eighth wonder of the world is the activity of Congressmen in and about a number of things that are useless, and in some cases, pernicious. One of the most startling examples of this proclivity has been manifested recently in the House of Representatives by the introduction of a bill in the 65th Congress by Representative Alexander for the ostensible purpose of regulating radio communication, which in reality is a bill calculated to wipe out the radio amateur in the United States and take away from the people at large all right to have wireless apparatus or to become proficient in the use and management of an amateur wireless station.

How serious such a prohibition would be to the interests of the country at large is revealed when we consider the part that the so-called "radio amateur" has played in the War for Freedom just closed. At the outbreak of the war the Government of the United States sent out a call for all the "trained radio operators" who would volunteer to serve the Government during the period of the emergency. More than 5,000 patriotic Americans, who had acquired skill in the operation of radio through the amateur wireless stations which they conducted, responded and made themselves available for the uses of the Army and Navy. Without amateur radio operators, the Government would have been obliged to take raw recruits, unfamiliar with wireless, and given them months of intensive training before the required personnel could have been added to the Signal Corps for wartime uses.

How important this was will be appreciated when we recall that a great modern General said, "The difference between good and bad communication on the battle line is the difference between life and death." The worst part of the introduction of this bill is that it is not the first time that Congress has felt called upon to attempt legislation against the radio amateur. In 1912 a bill was introduced in the House, somewhat similar in its provisions to the present one, which also contained no permission for "radio amateurs" to operate.

A wave of indignation swept the country at that time from the Atlantic to the Pacific, and so strong a protest was made that the bill was defeated; and a lucky thing for Uncle Sam it was, too, as otherwise there would have been no operators upon whom he could call to do the most urgent work of the war, except the mere handful of paid commercial operators. Now that Congress has been busy for the past year and a half taking over control of private enterprises on behalf of the Government, it undoubtedly feels that the time is ripe to take away from the people the privilege of using and maintaining wireless stations, and the bill is submitted once more to Congress with the hope of passing it under the cloak of an "emergency measure" which no one will have the courage to assail at a time like this.

The American people are fully awake and alive to the situation, however, and every organization, firm, magazine, and man in this country with the interest of amateur radio work at heart has taken up the gage of battle against a bill designed to deprive our country of its only source of supply of radio men in time of trouble. Everyone who has had any experience in radio work has had experiences with young men who have taken up wireless as an amusement at first, and who have afterward developed into first class radio operators and experts. The writer, in his long experience in conducting an amateur radio station has had opportunity to observe countless young men starting out in the amateur field, and has watched them grow into A1 technical men, better equipped even than the professionals, by reason of the fact that general amateurs by Governmental regulation must contend with the difficulty of operation with wave lengths of not over 200 meters. In addition, most of them use homemade apparatus, which is of great aid to them in teaching them the construction and design of apparatus for wireless use.

Short waves were almost universally used in the war for trench work, and by reason of the fact that amateurs had, by the Government restriction, been obliged to work on those wave lengths, they attained a skill which the Government experts had previously thought impossible. This was wholly due to the fact that the amateur had been forced to experiment with a spark transmitter tuned to 200 meters, until he was able to transmit and receive with any degree of accuracy, since the year 1912.

A similar bill to the Alexander Bill (H. R. No. 13159) has been introduced in the United States Senate (S. No. 5036) by Senator Fletcher in conjunction with the bill in the Lower House. Both of these bills must be killed if the radio amateur is to live. Whether it is worth while keeping the radio amateur alive is amply demonstrated by his use in the great war.

Congress should be made to understand that amateur stations are not cheap toys. I have personal acquaintance with at least fifty amateur equipments that are on a par with coastal stations in point of efficiency. My own station, 2 PM, cost about $500 in cash and a great deal of labor to construct. It could not be duplicated for $1,500. There are many other amateur plants of equal value.

Man to man, is it right for any Congressman or Senator to attempt by legislation to stifle the spirit of inventiveness and ingenuity in this line of work, especially in view of the noble and patriotic service just recently rendered to the country by the, now, despised amateur? It is not to the interest of the people in the perpetuation of republican institutions, to allow such laws to be passed!

John F. Grinan,
Owner of Radio Station 2 PM.

Experimenters' World

Langmuir's Circuit and Apparatus for Operation of the Vacuum Tube

A PATENT recently granted to Dr. Irving Langmuir of the General Electric Company shows a vacuum tube of unusual construction connected in a receiving set circuit for the detection of electrical oscillations.

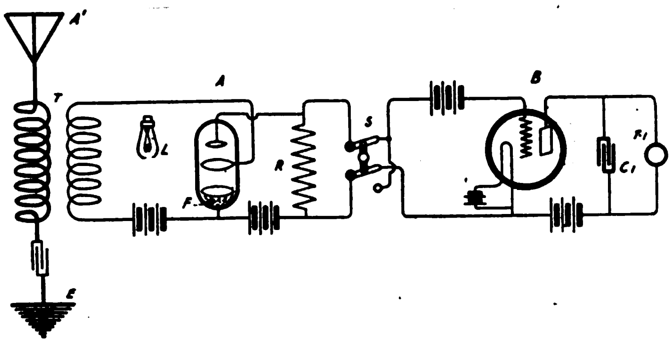


Figure 1—Langmuir's circuit and apparatus for amplifying variable currents

Figure 1 indicates a cascade system where the plate or output circuit of tube A is coupled to the grid or input circuit of tube B, through a resistance R. This usually has a value of 20,000 ohms.

The filament F is not heated by a battery as in the usual tube but it consists of potassium, sodium or other metal which emits electrons when illuminated by the source L.

A monochromatic source of light such as a mercury vapor arc in a quartz or glass envelope has been found to give off electrons of uniform velocity. The anode or plate preferably consists of tungsten and the bulb is exhausted of gas by electron bombardment during the exhausting process. The pressure in the envelope is reduced to a value at which no appreciable gas ionization can occur.

A two-way switch S is provided between the plate and grid circuit of figure 1 and when it is placed so as to connect the positive terminal of the resistance R to the grid circuit of the second tube, which contains a battery for making the grid negative, an increase of plate current in the circuit of the tube A will produce an increase in the plate current of the circuit of the tube B. When the connections are reversed the converse is the case. As in the usual receiving circuit the receiving transformer with its primary and secondary windings is indicated at A, the aerial at A′ and the earth connection E. The current translator is the telephone T-1, which is connected in the plate circuit and shunted by the variable condenser C-1.

The apparatus shown in figure 2 is the usual cascade radio frequency amplifier—a circuit applicable to the reception of damped oscillations. Through the tubes A and B, the incoming radio frequency currents are progressively amplified, the transformers T-1, T-2 and T-3 being air core radio frequency transformers of the necessary dimensions for tuning to an incoming signal. The secondary of the three transformers are shunted by variable condensers as usual. It is to be noted that the vacuum tube C includes in its grid circuit a series grid condenser C-1 which is shunted by the battery B-1 and the resistance R connected in series. The object of the condenser C-1 is to secure an integral effect of each group of incoming oscillations so that the effect in the plate circuit of the vacuum tube B is to produce an audio frequency pulse of current—one pulse for each spark at the transmitter.

The operation of this part of the circuit is well understood by the field at large, the amplified incoming radio frequency currents being rectified, accumulating a change in the condenser C-1 over the duration of a wave train which makes the grid increasingly negative, reducing the plate current. At the termination of the wave train the charge leaks out, the condenser C-1 being assisted in discharging by the battery B-1. Thus the grid potential of the valve is restored to normal value between each group of oscillations and consequently the maximum effect is obtained in the plate circuit.

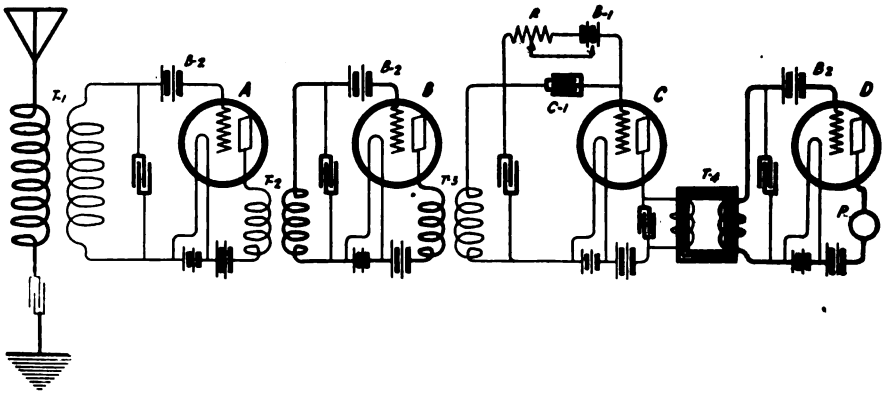


Figure 2—Usual cascade radio frequency amplifier

Tuning to audio frequency or, in other words, to the spark frequency of the transmitter is accomplished through the transformer T-4, which contains an iron core and is of the necessary dimensions to be resonant to frequencies around a thousand per second. The secondary terminals of T-4 are connected to the grid circuit of the tube D, the plate circuit of which contains the telephone transmitter P.

Both tubes have a source of grid potential—the special grid battery B-2—the object of which is to adjust the potential of the grid in respect to the filament to a slightly negative value, for this has been found to give the best signals.

The effect of the series condenser in the grid circuit of the tube C in figure 2 is shown by the graph in figure 3 where the successive cycles indicate how the potential of the grid to filament varies during the passage of a group of radio frequency currents. It will be noticed that the effect of the first half cycle is to make the grid slightly positive but as rectification occurs and a charge piles up in the grid condenser C-1, the grid

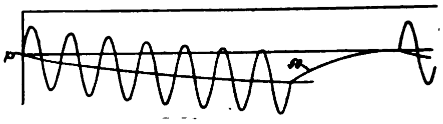


Figure 3—Graph showing how the potential of grid to filament varies

(*Continued on page* 34)

Vreeland's Selective Wireless Telegraph System

FREDERICK VREELAND believes he has solved the problem of selective and secretive wireless signaling by use of the apparatus shown in figures 1 and 2. The fundamental circuits admittedly are simple, the only unexplained device being the recording instrument to take down the signals. As a novelty of this system it is to be noted that in figure 1 a mercury vapor arc is employed to generate radio frequency currents, and at the receiver a small mercury arc generator is employed for similar purposes to form beat currents, the only thing of importance missing being the recording device, which the inventor remarks may be a telephone, a vibration galvanometer or a mechanically tuned relay. If the reader understands the working of the well-known beat receiver, little attention need be paid to the diagram.

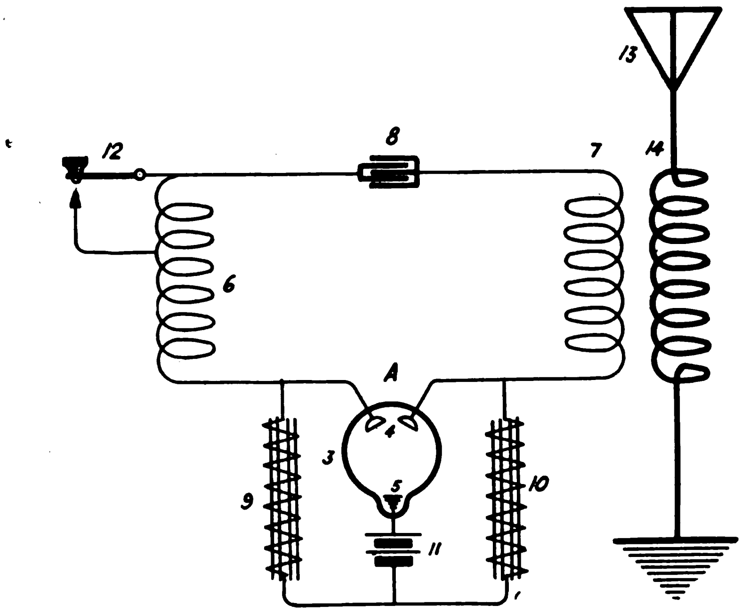


Figure 1—Circuit employing mercury vapor arc to generate radio frequency currents

As a fundamental working basis of the apparatus it may be said that when a local radio frequency generator at a receiving station is adjusted to the correct frequency for the production of audible beats, the difference in frequency between the local generator and that of the incoming signal is practically insufficient, in the inventor's opinion, to require separate tuning for the two currents. It is also evident that in a receiving system of this kind, adjusted for beats, the slightest change in frequency at the transmitter will produce a corresponding change in the beat note. This, in fact, is one method by which the inventor accomplishes radiotelegraphic signaling. For example, if the receiving apparatus in figure 2 is adjusted so that the frequency of the local generator is slightly different from that of the incoming signal, a continuous beat note will result in a telephone provided the transmitter is in constant operation. If then the transmitting operator presses the key 12 in figure 1, the slight detuning of the transmitting circuit occasioned thereby will cause a sufficient change in frequency to either increase or decrease the pitch of the beat current at the receiver. The operator will then translate the signal heard when the transmitting key is pressed and he may select as a normal pitch for the continuous note at the receiver, any frequency that will make clear the superimposed note.

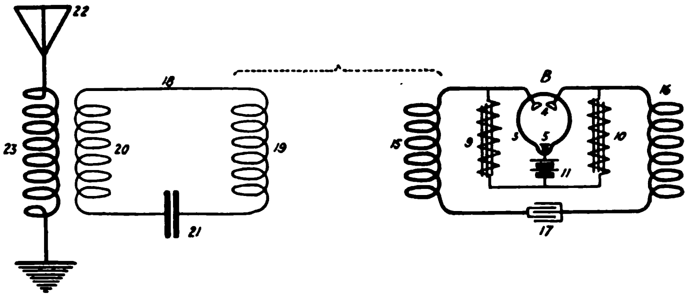


Figure 2—Receiving apparatus of Vreeland's selective wireless system

Assume again that the frequency of the local generator at the receiver is the same as that of the transmitter: No beat note will result but when the transmitting operator presses the key 12 detuning the transmitting circuit an audible note occurs in the receiver. A vibration galvanometer or a relay or other mechanically tuned receiving device may be adjusted to record the beats. Again the recording device may be such as gives no indication from the audio beat but responds to the intervals of silence in this case. It is evident that unless a spying station was provided with a similar receiver it would be unable to record the signals.

It is obvious that the beats need not be of an audible frequency, provided a receiver is employed capable of discriminating between the beat frequencies corresponding to the signal and no-signal conditions, such as a vibration galvanometer or relay, in which case the signals may be visually displayed or be recorded or both.

A numerical example will illustrate the very small change of frequency required at the transmitter to produce readily distinguishable audible tones. Suppose the frequency of the sending oscillator be 100,000 cycles per second and that of the receiving oscillator be 99,500 cycles per second, or one-half per cent less. Then the beat frequency will be 100,000 — 99,500 = 500 beats (cycles) per second, a rather high pitched musical note. If now the sender frequency be changed to 100,050 cycles per second (one-twentieth per cent higher) the beat frequency will become 550 cycles per second, a change of 10%, or nearly a whole tone of the musical scale, a marked interval easily observed. If the sender frequency be 100,000 and the receiver frequency be 99,900 (one-tenth per cent below sender) the beat frequency will be 100 (cycles) per second (a fairly low note) and a difference of only 10 oscillations or 1 in 10,000 will produce a 10% change in the beat frequency. A minute change in the sender frequency will therefore produce a relatively large change in the beat frequency.

LANGMUIR'S CIRCUIT AND APPARATUS FOR OPERATION OF THE VACUUM TUBE

(*Continued from page* 33)

becomes increasingly negative; at the termination of the wave train the grid potential returns to its normal value as indicated at P.

A feature of the cascade amplifier is, that by tuning successive circuits, the undesired oscillations are reduced in each case in geometric proportion. The additional selectivity occasioned by the use of the group frequency tuner, reduces the problem of interference to a minimum.

Construction and Operation of the Field Telephone and Buzzer

IN a previous article, I informed your readers of certain ideas which I developed in connection with field signaling work applicable to junior military organizations. In this article I present data for the construction and operation of a portable field telephone and buzzer set.

The portable station consists of the instrument case and carrying case. The carrying case has a compartment to hold two No. 6 dry cell batteries, which supply the power to the portable set.

The instrument case is made from the following pieces of kiln dried ¼-inch wood, preferably hard:

2 pieces 4¼" x 3" top and bottom
2 pieces 4 " x 3" sides
1 piece 3¾" x 3" front
1 piece 3½" x 3" back

Before assembling the case, mount the triple pole double throw switch on one of the sides, using two binding posts on the two arms to which the telephones are connected. The binding posts are used in place of the screws which hold the switch arm to the side. Connecting in this manner does away with complicated inside wiring. Fasten the buzzer to the base of the case, mount the strap key and two binding posts to the inside of the front so that, when the cover is opened, the key will be on the inside. The general assembly is shown in figure 1.

MOUNTING OF THE TRANSMITTER

The transmitter, as I stated in the first installment, should work on three volts, and be of very light weight. The Crown Telephone Company make the best transmitter that I know of. It is light in weight and works remarkably well on three volts.

As to the mounting of the transmitter there are several satisfactory methods. The first is to make an arm which is fastened to the back of the receiver, and has the transmitter mounted on the other end. The second method is to employ the mounting used for switchboard operators. I am unable here to give the exact dimensions for either method, as it depends upon the size and style of transmitter to be used. Probably the best style is the one used by telephone repairmen throughout the country.

It is my advice that the builder go to the telephone company in his city or town and obtain actual measurements of the style of apparatus he has decided to use. By so doing he will save a great amount of time and trouble. There are so many styles and types of receivers and transmitters that it is useless to consider any one type here. I might take a certain type as standard, which could not be obtained; therefore, I have left the matter for the judgment of the maker.

OPERATION OF THE PORTABLE SET

If the two sets after completion are not to be used through an exchange, or the exchange is not completed, be sure that the polarity of the battery of one set is reversed, in respect to the other set, for it is impossible to operate otherwise.

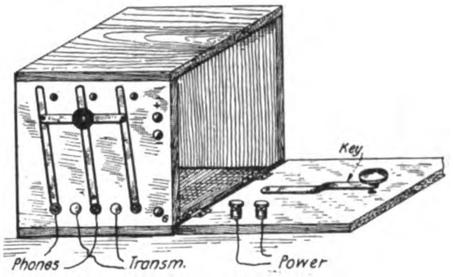


Figure 1—Portable station assembled and ready for use

In the portable set a small one-point switch must be employed so that the arm of the switch connected to the side of the batteries goes to the lower contact of the key, the other side to the line side of the circuit.

When the switch is closed the call light on the exchange will light up, notifying the operator that you wish to communicate with another station.

After finishing transmission, close the switch for at least five seconds. During that time the exchange operator will withdraw the plug connections.

Before calling a station—either the exchange or another portable set—have the T.P.D.T. switch on the buzzer side. Always have the switch on this side for calling, making sure to change back again after using the telephone circuit.

A copper rod 6 inches long must be carried with each portable set. This rod is connected by a wire and driven into the ground. The wire is connected to the ground side of the buzzer.

The following list of "Do Nots" if adhered to will save a lot of time and trouble:

DO NOT call the exchange by means of the telephone.

DO NOT leave the T.P.D.T. switch on the telephone circuit after using this means of communication.

DO NOT forget to see that the lines and batteries are connected up according to the diagrams.

DO NOT forget to notify the switchboard when you have finished transmitting your message.

DO NOT send anything unnecessary, as there may be important business for your commanding officer from headquarters.

DO NOT forget to make ground connections.

DO NOT fail to notify your repairman if the set fails to work.

WIRING OF SWITCHBOARD

The switchboard described in this article has a capacity of six stations; four line and two headquarters, or company and battalion.

A switchboard to be used for military organizations must have these requirements:

(a) Simplicity.
(b) Ability to send from one headquarters to all line stations.
(c) Calling and finish lights.

The switchboard in figure 2 has 17 binding posts, used as follows:

No. 1 through 12—To which the lines are connected.
No. 44 and 45—For power connections.
No. 46 and 47—For the telephones.
No. 47—Ground wire connections.
Six three-volt bulbs, Nos. 38 through 43.
Twelve plug receptacles for receiving the plugs Nos. 13 through 24.
Thirteen plugs, Nos. 25 through 36 and B.P.X. (Switchboard plug).

The reason for connecting together two plugs and two receptacles and one lamp follows:

If a station desires to communicate with another station, there must be some means of connecting them together. By connecting the plugs and receptacles of each set together, that is, when the plugs of one set are pushed into the receptacles of another set, a complete circuit is made.

In the set a buzzer and key are placed so that when the lights show that a station is calling, the exchange will have a means of answering and calling.

CONSTRUCTION OF THE SWITCHBOARD

The switchboard shown in detail in figure 3 is made of wood which is ¼" thick.

The following pieces must be cut accurately if a neat switchboard is desired:

2 pieces 7½" x 13½"—sides, cut as per figure 3
2 pieces 6 " x 6 "—upper front & back (A & B)
1 piece 7½" x 6 "—lower front (C)
1 piece 7½" x 6 "—lower back (D)
1 piece 8 " x 6 "—bottom (E)
1 piece 5 " x 6 "—plug board (F)
1 piece 1½" x 6 "—back mount (G)
1 piece 1½" x 6 "—top (H)

The pieces were designed so that the back is entirely removable in order that the wiring may be done in a neat manner and yet permit free access to all parts.

Take the two sides and mount front C on them, then set on bottom E and fasten with screws. Take the back mount G and mark off 10 holes as shown in figure 3, part A, and drill with a ⅛" drill; then mount 10 binding posts with a base diameter not to exceed ¼". Slightly smaller posts would perhaps be preferable. Next put on the top H.

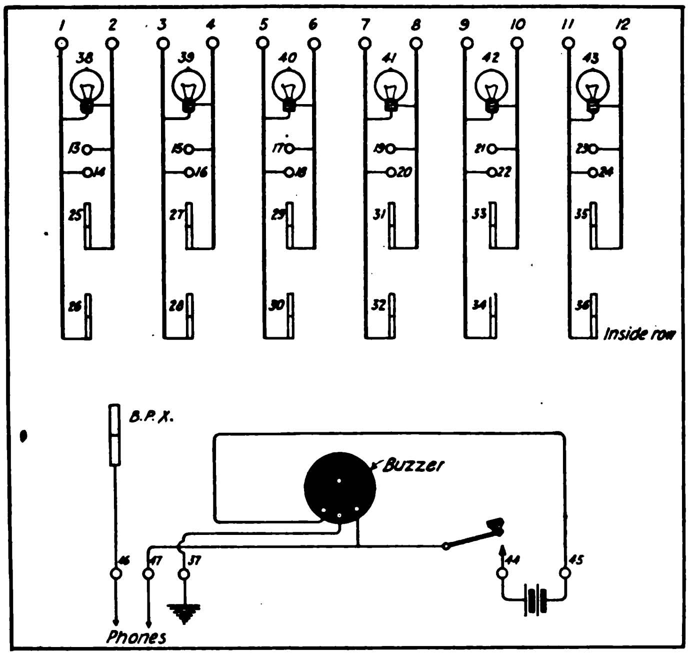


Figure 2—Showing wiring for switchboard

On the upper front A mark off and drill as per figure 3, part B. Cut twelve strips of copper ¼" wide and 1½" long. Bend each strip ½" from one of the ends; mount one over each hole as shown in figure 3, part C.

After drilling all holes, including those for the lamps, (the size of these holes depends upon the size and style of bulb), and the copper strips are in place, mount the board and proceed with the wiring. From each set of contact arms run two wires, one to each arm to the lamp corresponding to the contact arms above as per the wiring diagram figure 2. There are ten binding posts, 1 through 10 starting at the right when the back is toward you. Numbers 2, 4, 6, 8 and 10 are marked (+) and the others (—). The even numbers are connected to the upper row of receptacles No. 2 to No. 13, etc. The uneven numbers are connected to the lower row No. 1 to No. 14, etc.

Take five pieces of flexible wire each 14½" long and fasten one end of each to binding posts Nos. 1, 3, 5, 7 and 9.

Take five pieces of the same wire each 17" long and fasten one to each of the remaining posts.

Drill the plug board (F) as shown in figure 3 and mount as shown. Drill the short leads through the holes nearest the front A. Pull the longer leads through the remaining holes.

Cut two wires, one 14½" and the other 17" long, and connect to the two headquarters binding posts on the side. Also connect plug receptacle No. 23 to post No. 12 and No. 24 to No. 11, being sure to connect the lights at the same time. Pull the two leads through the remaining holes.

Make thirteen weights of lead each 1" square and drill a hole through the center. Fasten one to each of the leads, on the short leads 5" from the end joined to the binding posts, and on the long leads 6" away. These weights will be heavy enough to hold the wires in place when not in use, and are heavy enough to cause the wires to return to their original position, when released from the plug receptacle. Connect regular telephone plugs on the end of the wires coming through the mount and make the final adjustment on the weights. I offer the following suggestions: Use six black and six red plugs, the inside row of plugs black and the outside row red, the exchange plug red also. Paint a small red ring around the upper row of plug receptacles and black on the lower ones. By doing this, many a mistake will be avoided. Mount a buzzer inside the case and connect to the binding posts marked on figures 2 and 3. Cut a flexible wire 17" long and connect one end to the binding post No. 46, pull the other end through the hole provided for it, fasten a plug and a lead weight. Make the adjustment so that the plug will fit into any one of the plug receptacles. Then mount key and finish the remainder of the assembly.

Testing

After the switchboard is connected it must be tested, not with a portable station, but with a quicker method. Take two dry cells and connect together. Connect the two wires to binding posts No. 1 and No. 2. If properly wired, the light No. 38 should burn. Push plugs 25 and 26 into the plug receptacles of each set and if the lights burn they are correctly connected.

The next step is to see that all the plugs and plug receptacles are connected properly. Take the two batteries and connect one side to binding post No. 1. The other side to one side of a bell, and from the other side of the bell a long wire is attached so that it can be connected to Nos. 3, 5, 7, 9 and 11 in rotation. Connect to No. 3, and push plug 26 into receptacle 16; if the bells ring the circuit to this point is correct. Change the bell wire to No. 5 and plug 26 to 18. Do this to Nos. 7, 9 and 11, being sure to use plug 26 in all cases. If the bell rings each time you change the wire and push the plug into the corresponding receptacle, the circuit is O.K. If it does not ring immediately change the wires of the binding posts. It will then ring. By making these simple tests you will know whether you have done your work properly.

Operation of the Switchboard

When the switchboard and stations are ready for use, connect the lines from the portable station to their respective binding posts on the switchboard. Be sure to have the line side from the portable set connecting to the (+) binding post on the switchboard, the other wire connected to the (—) side.

When the call switch at the portable station is closed, the light across the two binding posts to which that station is connected will burn. Push the exchange plug into the upper row (+) of the receptacles into the one corresponding to the station calling. Send RK, which means "All right, go ahead." The station calling will then send the call letter of the station wanted, which is acknowledged by repeating the call letter or letters once. Now push the plug or plugs of the station calling into the plug receptacle (s) wanted and press the key once. This is to notify the other station he is wanted; then remove your plug. When I say plugs, I mean this: when the buzzer is to be used you only need one plug. On the wiring diagram of the switchboard they are the plugs with the uneven numbers, No. 25, etc.

When the telephone is to be used, the calling station will signify by sending the call letter of the station wanted twice, followed by the letter T twice.

Push the + plug into the — receptacle and the — plug into the + receptacle of the station wanted.

The reason for crossing the lines is that all stations are wired up in the same way, all plug sides of the batteries on each set being joined to the same instruments. When the buzzer is in use it makes no difference whether the power is the same or not. With the telephone the batteries must be in series. That is, the positive side of the batteries on one set must be connected to the negative side of the batteries on the other set. That is why two leads are used, and why they are reversed when the telephone is used.

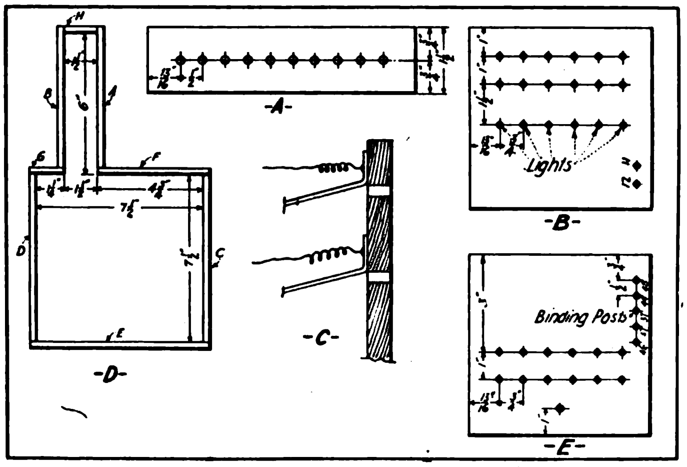


Figure 3—Plan of construction for switchboard

If headquarters wishes to communicate with one station, the preceding methods are true, but when a communication is desired with all stations at the same time, it is changed to this extent:

If the buzzer is to be used push plug No. 35 (which is one of the two regimental plugs) into plug receptacle No. 21, plug No. 33 into No. 19, No. 31 into No. 17, No. 29 into No. 15, No. 27 into No. 13 and plug 25 will remain. There is one left over because the receptacles and plugs of each set are connected together. Connected in this manner all stations are in series. Send a long dash followed by R.

When using the telephone both plugs must be used. Plug 35 into 22, 36 into 21. Proceed in the same manner as in the buzzer, being sure to reverse the plugs. Hold down your key for at least five seconds, then send RT, which will tell the operators that headquarters is about to transmit by means of the telephones.

The preceding feature is of great use and I am safe to say, original, in allowing direct or selective communication from the commanding officer and all officers of the line.

HEADQUARTERS STATION

The headquarters station may be of two different styles: either a portable set, or a switchboard of the type used by the exchanges. An exchange is the proper thing to install, if possible, for the advantages are obvious.

When an exchange is used at headquarters, three portable sets are employed, each set connecting with one set of binding posts. The other three sets have the lines from the exchange connected to them. The following shows the number of intercommunications possible:

1—Transmission to one or all stations of one company.
2—To one or all of two companies.
3—To one or all of three companies.
4—Working three different stations at the same time.

WHO PAYS FOR THE APPARATUS

Each company or battery will furnish a portable set, to be kept by that company. They will also have two men trained as operators.

The companies making up a battalion will each contribute an equal amount of money for the cost of constructing an exchange. The Signal Corps will furnish the operators.

All companies will bear the expense of equipping headquarters with a portable set or exchange, to be kept by the Signal Corps. All operators for headquarters to be drawn from the Signal Corps.

The wire to connect up the apparatus will be furnished in the same way, excepting that the Signal Corps will supply the wire to go from each exchange to headquarters.

INSTRUCTIONS FOR OFFICERS

1—An instruction school to be conducted by the Signal Corps in operation, maintenance, and construction of the apparatus.
2—Have three trained men who are to be expert repairmen and "trouble shooters," trained on both the portable set and switchboard.
3—Hold an examination for appointment to the grade of Master Signal Electrician. If you already have one, detail this sergeant to study this apparatus.
4—Each man should become a specialist, either as an operator, lineman or repairman.
5—Buzzer practice should be continued until every operator is able to copy at least fifteen words per minute.

If this advice is followed a great deal of unnecessary trouble will be avoided and a "crack" Signal Corps will be the result.

LIEUT. R. D. GREENMAN, U.B.B.A.

Multi-plate Spark Dischargers for Quenching Effects

A QUENCHING spark gap designed by E. J. Simon is shown in the accompanying figures 1 and 2, where two discharge gaps are in series to form the unit of a complete gap.

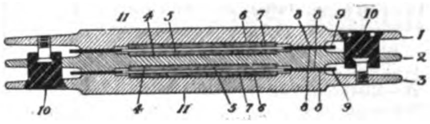


Figure 1—The Simon quenching spark gap

Figure 2 is a plan of a single plate showing the recesses 10 for the insulating bushing.

In figure 1 the intermediate plate 2 is provided with a seat or recess 4 of circular outline. The sparking plate 5 is preferably of electrolytic copper secured to the face of the plate 2. Copper plates 1 and 3 are constructed as plate 2 except that they are grooved on one side only. An insulating gasket 9 is interposed between the plate and it is made of special material such as will insure an air-tight joint.

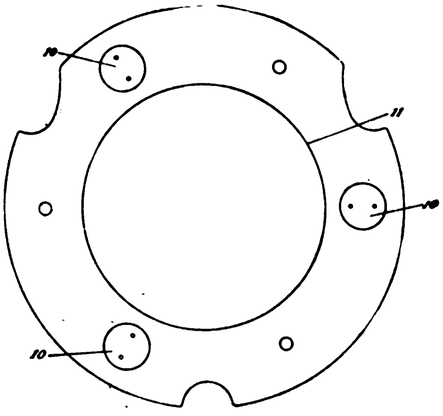


Figure 2—Showing plan of a single plate

At the points where the circumference of the plate makes contact with the insulating gaskets a series of circular grooves are cut in order to insure air-tightness.

The plates are tightly clamped together by the insulating bushings 10, which are drawn up by a small machine screw.

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Contest for the January 1919 Issue Wireless Age

In response to the call in the November issue for manuscripts concerning the prevention of interference in amateur radio communication, prizes have been awarded to the writers of the following contributions. The subject upon which the contest was based was: "WHAT IN YOUR OPINION IS THE BEST METHOD TO PURSUE TO PREVENT UNNECESSARY INTERFERENCE IN THE EVERY-DAY USE OF WIRELESS TELEGRAPH APPARATUS?"

First Prize—Some Technical Aspects of Wireless Interference

IT is clear that if all amateur transmitting stations are to operate on the same wave length, and moreover they have been adjusted so that the radiated wave complies with the U. S. laws, a certain amount of interference is bound to result.

It would, therefore, seem highly desirable that the range of wave lengths allotted to amateurs be increased to, say, 300 meters, in order that different wave lengths may be designated to various localities. Committees selected by amateurs throughout the United States should designate the range of wave lengths to be employed in various districts, and these should be adhered to. If the use of such wave lengths is enforced, a great amount of interference heretofore experienced will be prevented, irrespective of the type of apparatus in use.

It is quite probable that vacuum tube transmitters and receivers will play an important part in future operations of the amateur, for the reason that they can be employed for the generation of continuous oscillations at wave lengths as low as 200 meters. Then by the employment of the heterodyne receiver a remarkable degree of selectivity will be secured, owing to the beat phenomenon itself. Whether or not the vacuum tube transmitter will be supplied to the amateur field at a price within the range of its financial resources is at this writing problematical, but it is certain that the only part of the vacuum tube transmitter that the experimenter will actually need to purchase will be the bulb, for all other apparatus connected therewith can readily be constructed by any experimenter handy with tools.

In order that the wireless experimenter may derive the benefits to be expected from the use of such apparatus a campaign of education regarding its use must be inaugurated. We will rely upon The Wireless Age to do this, but once the operation of the vacuum tube is understood, the amateur with most elementary knowledge will be able to adjust such a vacuum tube set for its maximum efficiency.

Even in the use of damped wave transmitters, increased selectivity can be obtained by employing a regenerative vacuum tube circuit. Any experimenter who has employed this apparatus has immediately observed that the use of regenerative coupling increases the factor of selectivity because it has the effect of reducing the total damping of the receiving circuits.

Many experimenters have not obtained good results from the regenerative amplifier because they have not been given proper constructional details, but I am sure that loads of amateurs—readers of The Wireless Age—have designed good circuits and will be glad to inform others through the columns of this department concerning the details of their design.

Experimenters have observed that the vacuum tube oscillation detector itself increases the factor of selectivity. This is accounted for by the fact that if the grid of the tube is held at a negative potential, the tube does not absorb energy from the oscillation circuits. The damping is therefore reduced and the sharpness of tuning accordingly increases.

For short distance amateur communication, that is, between stations within the same city, there is not a particle of doubt that the buzzer transmitters which have been so effectively employed in government communication will be adopted by the radio experimenter. This transmitter is of simple construction and inexpensive.

Regarding the lawless amateur, the fellow who jams the atmosphere promiscuously without regard to what is going on; he should be dealt with by police committees of local radio organizations. On top of this the government restrictions should be such that this type of experimenter will not be permitted to operate his equipment until he passes a fairly rigid technical examination and is able to receive and transmit in the International telegraph code at speeds between 15 to 20 words per minute.

I am very optimistic regarding the future of the wireless amateur. I believe that the new inventions brought out during the war will aid him in every way and make his work more interesting, as compared with the types of apparatus used in the pre-war period. Constructional details of sets incorporating the results of recent research will undoubtedly be presented to the field at the proper time.

A. J. Holborn, *New York.*

* * *

Second Prize—Interference

IN discussing this subject it would perhaps be well to first apply a bit of analysis. Interference is an effect and there is necessarily a cause to every effect. We must therefore investigate the various causes of interference before we can prescribe a remedy. Briefly stated, all interference may be placed under one or another of two general classifications: Static, arc lights, trolley cars, etc., may be placed under one head; and as these offenders are purely physical, they follow certain well defined laws of nature which can be accurately determined by careful study, and eventually a scientific means of nullifying their effects will be evolved.

The offenders who come under the other head are beings who follow undefined laws of human nature; they can never be controlled by any physical means but must be handled by moral suasion

For the offenders in the first class various remedies have been applied from time to time by many of the foremost authorities on radio, with some success. This topic is one of the chief subjects of research by all investigators, and the fellow who is actually successful in discovering a perfect cure for "static" will win fame and fortune immediately.

The following suggestions bear solely on the control of interference from offenders of the second class:

In reviewing operating conditions in the amateur field up to the time the stations were closed, certain facts become evident. Before the sinking of the Titanic, when the amateurs were free and unrestrained, you could listen in any evening to as fine an imitation of a jazz band as one could desire. No matter where you paused in your tuning, amateur stations with most every known and unknown tone and volume of spark could be heard asking each other "how they came in"—this was ever the chief topic of conversation. When the restrictive radio laws were put into effect, it was thought the death knell of amateur radio had been sounded, as very few supposed any distance could be covered with such small power inputs. However, on the contrary, it proved to be beneficial instead of disastrous in its effects. It took the joy out of life for many triflers and they dropped out of the game. It taught the amateur the value of efficiency, however, as this was the only path left open for increasing his range. It also furnished incentive for serious attempts to advance his work, as it gained him public recognition. And last, but not least, it taught a lesson in respecting the rights of others. All this is established fact and is ample proof of what can be accomplished by proper legislation when justly enforced.

Now let us consider what resulted from this incentive for betterment among amateurs:

The theory of radio was more seriously investigated and applied in the construction and operation of his instruments, and manufacturers had to supply better and more efficient apparatus to suit his requirements. With this better equipment came a natural desire to use it to better advantage, and the standards of operating were raised. At this point the possibility of extending operations into adjoining states was seriously considered, and it was soon realized that in order to accomplish this some definite system would have to be adopted that would enable the efforts of the various individual stations to be brought into harmony, prevent misunderstandings and allow all to pull in one direction. This led to organization of a body of serious minded amateurs, and lines of communication were established throughout the country over which messages were routed. The results obtained exceeded the fondest hopes of the past, and amateur radio was given a new lease of life. All this is likewise established fact and proves what organization can accomplish.

Retrospect is always pleasant, but in this I have an object, and that is to remind you by way of example, of the power *proper legislation and organization* can exert in the amateur field to accomplish a purpose. It is by these means that I believe the evil of unnecessary interference can be eventually cured. It cannot be hoped to make much headway in this direction by the scattered efforts of a few individuals or small groups. The problem is such that it will require the concentrated labor of practically all the amateurs, united in the common cause and working in harmony in a persistent effort to solve it. It is suggested that after stations are opened, the N. W. A. and other bodies representing the interests of amateur radio, co-operate in a nation-wide movement to eliminate unnecessary interference. A joint conference should be held for the discussion of ways and means. Some definite plan should be agreed upon, such as arranging a time schedule and rules of operation that will give every one a chance, by dividing the twenty-four hours of each day into appropriate periods of time and allotting same to the various classes of radio traffic, the most advantageous periods for the most important work, etc. Then these official rules and regulations should be declared broadcast to all stations through every available channel. By adopting an appropriate slogan and pushing the campaign with enthusiasm, it is bound to reach all concerned with gratifying results. And legislation of the amateurs by the amateurs and for the amateurs is most likely to be respected by all.

J. A. WEVER, *Maryland.*

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Third Prize—It Rests with the Amateur

I THOROUGHLY believe that the prevention of interference amongst amateur radio stations lies within control of amateurs themselves.

Technical considerations have been avoided in the following suggestions, for my long experience shows me that it is up to the amateurs to apply the "Golden Rule" to as great an extent as possible. There are enough publications devoted to the amateur to supply him with the necessary knowledge to build a transmitting and receiving set that will give a large factor of selectivity, and since it is perfectly obvious that when a number of transmitting stations operate at the same wave length, interference must result, the whole matter resolves itself back into my former suggestion, namely, we must apply the "Golden Rule." Consideration for our fellow worker above all else will solve the problem of interference, even though it may be argued that as long as we comply with the laws laid down for us we are entitled to have the free use of the air. It is only fair that we keep our hands off the transmitting key once in a while and just sit in and listen, giving the other fellow a chance. Messages of importance should always have preference over mere idle chatter.

Frequently, I have listened in and heard more than a dozen amateurs within a given vicinity, trying to use the air at once. It reminded me of a stock exchange where you find perhaps a hundred men yelling at the top of their lungs, something they wanted you to understand. Perhaps you have seen them waving their arms, dodging back and forth frantically with no real result, until silence was enforced.

Although I believe we must appeal largely to the good sense of the amateur to prevent interference, we must not forget the necessity of having our transmitters properly tuned, so as to emit a pure wave and get the maximum efficiency therefrom. It seems feasible to train an amateur in the operation of adjusting his apparatus to such an extent that he can pre-determine its efficiency without unnecessary and constant querying from his fellow worker, "how do you get me?"

My opinion, in brief, is that the first consideration is to have a transmitting and receiving apparatus adjusted for maximum efficiency, and second to have the amateur use his good sense—not to act as if he were the sole owner of the space surrounding him.

H. B. NORDSTROM, *Minnesota.*

Locking Device for a Variable Condenser

WHEN variable condensers are employed in wireless telegraph apparatus subjected to jar and strain such as the equipment installed on an airplane, it is essential that they be provided with a locking device that will prevent the movable plates from rotating without putting a severe strain on the condenser mechanism itself.

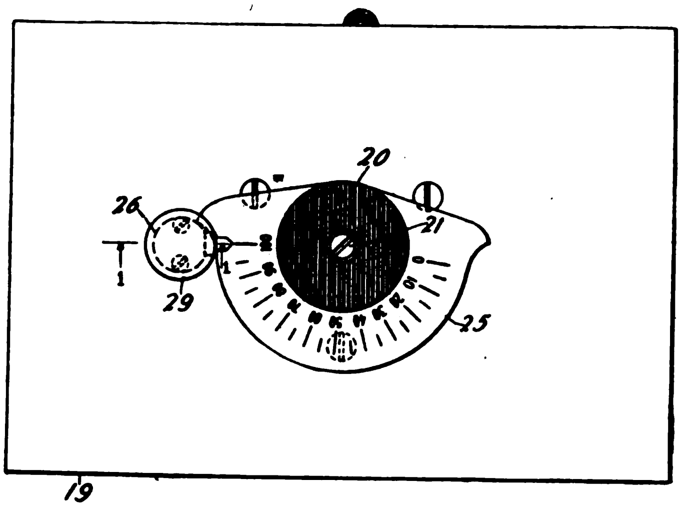

Figure 1—Plan view Gargan locking device

The movable plates of the average variable condenser are not balanced with respect to the rotating shaft and a tendency therefore exists for them to work out of position when subjected to vibration. Also during shipment it is desirable to have these plates locked in position to prevent the apparatus from damage due to rough handling. If there is but a slight separation between the movable plates and the fixed plates, it is highly desirable that the locking device employed be constructed so as to prevent any possibility of the strain changing the separation between the two sets of plates.

John Gargan of Brooklyn, New York, has recently shown a design for a variable condenser embodying this construction as shown in the accompanying figures 1, 2 and 3, figure 1 being a plan view, figure 2 a side elevation, and figure 3 a detail of the locking device.

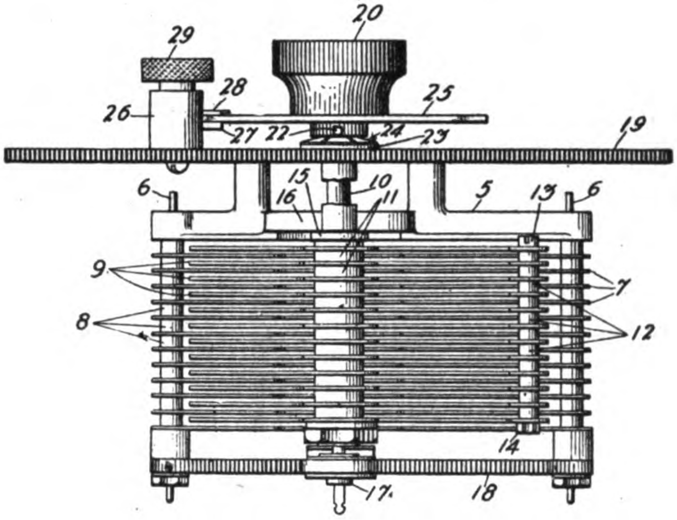

Figure 2—Side elevation Gargan locking device

In the detail of figure 3 the locking device comprises the clamps 27 and 28 which grips the plate 25 attached to the handle of the variable condenser. It consists of a hollow post 26 rigidly secured to the mounting plate 19 and provided with a longitudinal slot through which extends a pair of floating jaws 27 and 28. The jaw 27 is assembled to lie in a plane below that of the indicating plate 25 and its inner end is provided with a threaded opening adapted to engage corresponding threads in the knurled head screw 29. The inner end of jaw 28 is provided with an opening through which the threaded portion of screw 29 passes freely and its outer end is pointed to serve as a pointer for the indicating plate 25. Between the jaws 27 and 28 within the post 26 is located a washer 30 of a thickness somewhat less than that of the plate 25. Upon turning the screw 29, the shoulder portion 31 of the screw engages jaw 28, thereby clamping the indicating plate 25 firmly in position.

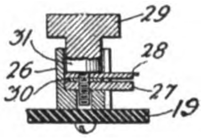

Figure 3—Showing a detail

Coolidge's X-Ray Tubes

THE exhaustive researches of William D. Coolidge in the X-ray field are well known to readers of THE WIRELESS AGE. He has recently shown the design of two complicated structures as per the accompanying drawings figures 1 and 2.

The tube in figure 1 comprises an envelope consisting of an inclosure 1 of metal such as copper and an inclosure 2 of insulating material, preferably glass. A section of platinum 3 is welded or soldered to the copper wall at 4 and is sealed to the glass wall at 5. A copper tube 6 is welded or joined to the tube 1 at 4 and extends into the insulating part 2 of the envelope at the joint 5.

The cathode is a coiled filamentary conductor 7 consisting preferably of tungsten. In this diagram it is shown on edge. Surrounding the filament is tube 8 of molybdenum or other suitable conductive material which acts as a focusing device. One end of the cathode filament is joined to the focusing device and the other end to the conductor 9. Two wires 10 and 11 are joined to the tube 8. They are secured to a split tube 12 of molybdenum or iron. The wires 9, 10 and 11 are bound together by bridge 13, suitable insulation being used if the bridge consists of conducting material. The wires 9 and 10 are sealed into the closed end of the tube section 2. The cathode structure is carried by tube 14 of glass or a suitable insulating material.

An anode plate or target 15 is applied within the metal end 1. It consists of tungsten or other suitable refractory metal. The target is cooled by water, air or other suitable cooling fluid circulating through a chamber back of the anode into the wall of which are sealed tubes 16 and 17 for supplying and withdrawing the cooling fluid. Opposite the anode is a tube 18 closed with a window 19 of thin metal, glass or other material relatively transparent to X-rays.

The tube is exhausted of gas to a pressure so low that the conduction of electricity can occur between the cathode and anode across the vacuous space independent of positive gas ionization.

During the exhausting process, traces of oxids which are apt to give off gas during the operation of the tube may be removed by introducing

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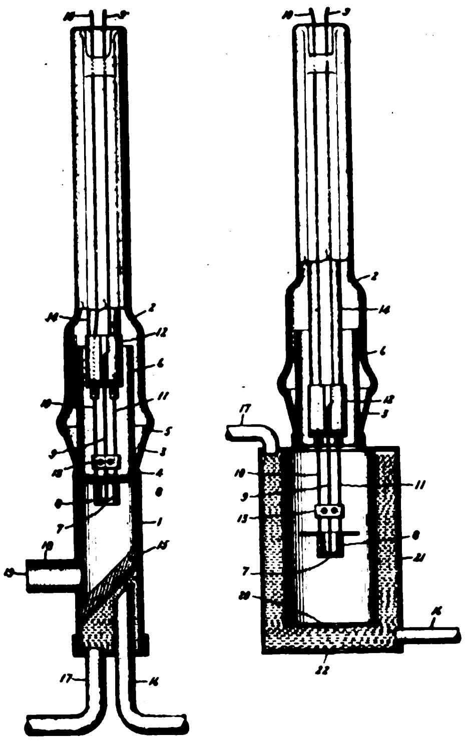
hydrogen gas, heating the walls of the tube externally and then re-exhausting to the required low pressure, say, below .05 of a micron of mercury pressure.

To place the tube in operation the cathode 7 is heated to incandescence by passage of current and a source of current of suitable voltage is connected at its negative terminal to the cathode and at its positive terminal to the anode housing 1 with which the target plate 15 is in electrical contact. The electrons emitted by the cathode travel under the influence of the electrical field to the anode where X-rays are produced by their impact. The cathode rays are focused by the electrostatic field of the ring 8 to strike a spot of limited area on the target. Some of the X-rays are permitted to leave the tube through the window 19 so as to be available for use.

The tube shown in figure 2 is similar to that in figure 1 with the exception of the anode construction. The cathode rays strike an anode plate 20 consisting of thin metal such as platinum or silver where X-rays are generated which pass through the cooling fluid contained in an outer housing 21 and out through a window 22 which may consist of thin metal, for example, aluminum. If the plates 20 and 21 are made very thin, some of the cathode rays will pass through the same and will be emitted from the tube so as to be available for therapeutic or other purposes.



Figures 1 and 2—Coolidge electron discharge device

Suggestions for the Experimenters' World

We will pay the usual prizes of $10, $5 and $3, in addition to our regular space rates, to the three contributors who send us the best manuscripts on the following subject:

WHAT RESTRICTIONS SHOULD BE IMPOSED UPON AMATEUR TRANSMITTING SETS IN RESPECT TO POWER INPUT AND WAVE LENGTH?

Limit your manuscript to 800 words.

Queries Answered

Answers will be given in this department to questions of subscribers, covering the full range of wireless subjects, but only those which relate to the technical phases of the art and which are of general interest to readers will be published here. The subscriber's name and address must be given in all letters and only one side of the paper written on; where diagrams are necessary they must be on a separate sheet and drawn with India ink. Not more than five questions of one reader can be answered in the same issue. To receive attention these rules must be rigidly observed.

Positively no Questions Answered by Mail.

L. W., Seattle, Wash.:

Ques.—(1) Referring to the book "Vacuum Tubes in Wireless Communication" which of the two circuits give the best results—figure 69 on page 103 or figure 80 on page 119?

Ans.—(1) These circuits are practically identical. The only difference is that figure 69 has a sensitizing circuit, L-6, C-6. Identical results are obtained from direct or inductive coupling, but as you well understand it is less difficult to adjust the coupling in a two circuit tuner than in a two slide coil. You are also aware that the coupling in figure 80 may be adjusted in the following manner—the sliding contact in the lower end of coil L-1 is moved towards the earth lead and sufficient inductance is added at L-2 with the other contact attached to the antenna until actual resonance is secured. The coupling can thus be gradually reduced to any desired value. From the standpoint of simplicity, figure 80 is recommended.

Ques.—(2) Would it be of any value to substitute variometers for inductances L-4 and L-5, figure 69?

Ans.—(2) If variometers were employed they would have to be of unusual dimensions, for these coils, if of the single layer type for the reception of long wave lengths, are from 24 to 30 inches in length and 4½ to 6 inches in diameter wound with No. 30 or No. 32 wire. The necessary closeness of adjustment for resonance can be secured by condenser C-2 for the plate circuit and C-1 for the grid circuit.

Ques.—(3) Would the addition of an audio frequency transformer in the secondary circuit, figure 69, be of any value in receiving damped waves?

Ans.—(3) Your query is not thoroughly understood. We do not know whether you refer to an audio frequency regenerative transformer or whether you propose to attach an audio frequency transformer in the plate circuit of the valve for cascade amplification.

Ques.—(4) Can such a circuit as figure 69 discloses be operated with two or three valves in cascade? If so, please give diagram and state capacities of condensers and size of inductances.

Ans.—(4) There are sufficient diagrams in this text-book to cover every possible requirement, and if you will study carefully the text, you will be able to devise a diagram entirely satisfactory for your use. An audio frequency cascade amplifier could be connected in the telephone circuit of this valve, using iron core transformers between the plate and grid circuits of successive tubes.

Ques.—(5) Will the circuits of figures 68, 69 and 80 operate equally well with either damped or undamped oscillations?

Ans.—(5) The circuit is applicable for the reception of signals from either type of transmitter. For the reception of damped oscillations, the apparatus should be adjusted just to the verge of oscillation, but for undamped oscillations the circuit should be set to oscillate at a radio frequency slightly different from that of the incoming signal. The beat phenomenon may be employed in the reception of damped oscillations with marked amplifications of the incoming signal, but the normal note of the spark transmitter will be distorted.

* * *

K. K. K., Elizabeth City, N. C.:

Ans.—(1) The wiring diagram for the receiving set shown in your recent communication is in error at two points. The secondary loading inductance L-2 is not connected in the circuit. It is merely attached to one end of the secondary coils of the loose coupler. It is also evident that you propose to regulate the plate voltage by a series rheostat. If you will stop to think over the conditions present in this circuit, you will see that a series rheostat of an extraordinary value of resistance would be required to get the proper voltage regulation. What you require in this circuit is either a multipoint switch which will connect the cells of the circuits in groups or a shunt potentiometer of about 3,000 ohms resistance. A semi-circular piece of graphite is usually employed to act as the potentiometer. In all other respects the diagram is correct, but for the reception of undamped waves you should have a certain amount of coupling between coils L-2 and L-3.

* * *

T. B., Freehold, N. J.:

Questions 1 and 2 in your recent communication are fully answered in the text-book "How to Conduct a Radio Club," on sale by the Wireless Press, Inc., 25 Elm Street, New York City.

Your third query in respect to providing means for varying the frequency of a "howler": The natural frequency of such a circuit is largely governed by the dimensions of the diaphragm. The frequency can be changed somewhat by adjusting the spacing between the magnets and the diaphragm or by proper design of the associated circuits. If you will send us a diagram of the particular "howler" you employ, we can then supply more definite data.

* * *

A. S., East Watertown, Mass.:

A number of diagrams have appeared in past issues of the WIRELESS AGE covering combination apparatus suitable for the reception of damped and undamped oscillations.

The natural wave length of the 125 foot aerial you propose to erect, after the ban is lifted, will have a natural wave length in excess of 200 meters. The flat top portion should not be more than 100 feet in length.

* * *

A gentleman who forgot to sign his name and address inquires:

Ques.—(1) Explain in simple terms, the construction and functioning of ampere hour meter.

Ans.—(1) A detailed explanation appears on pages 72 and 73 of "Practical Wireless Telegraphy" and no more simple explanation can be given. It is nothing more than a small motor which rotates in one direction as the storage battery discharges and the opposite direction as it charges. The motor is geared so that the scale indications are proportional to the ampere-hours of current flowing.

Ques.—(2) On page 187 of "Practical Wireless Telegraphy" it says that as a proper diagram for the government operator's examination figure 209 added to figure 207 will be satisfactory. Explain just how the connections are made.

Ans.—(2) You should have no difficulty in working out details of this diagram yourself. You will observe in figure 209, 8 connections for the volt meter. The terminals 3 and 4, for example, marked "battery unit A," should be connected across the terminals at battery A in figure 207 and so on with the remaining connections. In the Government examination you do not need to show the motor generator with automatic starter indicated in figure 207, but the terminals 5 and 6 in figure 207 should be connected to the "110 volts, DC" connections in the upper left hand corner of figure 111, page 98, of "Practical Wireless Telegraphy."

Ques.—(3) What is the function of the shunt condenser of the secondary receiving transformer?

Ans.—(3) The function of this condenser is to adjust the secondary or closed oscillation circuit to resonance with the incoming signal. By properly adjusting the inductance and capacity for a given wave length, the damping of the secondary circuit is thereby changed, permitting an adjustment favorable to the maximum strength of the signals.

When the coupling between the primary and secondary circuits is relatively loose, marked selectivity can be secured by the use of fairly large values of secondary capacity, but with loose coupling, smaller values of capacity will give the loudest signals.

Ques.—(4) What apparatus do you advise for the detection of undamped waves?

Ans.—(4) The best results are undoubtedly secured with the vacuum tube circuits, known otherwise as the self-heterodyne or "Autodyne." These circuits are completely described in the text-book "Practical Wireless Telegraphy" and "Vacuum Tubes in Wireless Communication."

Ques.—(5) I desire to join the N. W. A. To whom shall I apply?

Ans.—(5) Place your application with Headquarters at 25 Elm Street, New York City.

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Electrical Digest

Reconstruction After the War

IF we have correctly sensed the attitude of our contemporary The Electrical Review, there will be no room after the war for the industrial leader with pessimistic ideas. An inevitable readjustment of industrial affairs must follow, but if we believe that unsurmountable chaotic conditions will prevail, we are following a line of argument that will lead into just the condition which is to be avoided.

Business men must make an extraordinary effort to maintain a mental poise during this period. They should not be over optimistic or over pessimistic. Such well-known men as Otto Kahn, the great New York banker, believes that although "the immediate sequence of the ending of the war is bound to be an interval of confusion and readjustment, during which certain industries will be favorably or unfavorably affected, at the completion of the process there should be for a few years at least an immensity of opportunity and a corresponding prosperity producing activity such as even this country has rarely experienced."

We are urged to recognize and respect the demands of the new day, which is a day of progress and social justice and of the searching and testing for the right.

In a recent editorial, the Electrical Review urges that Congress should take up a definitely charged body with the numerous problems involved and the drafting of the most practical solutions thereof. One of the conditions on which a satisfactory solution is based, is the establishment of goodwill between employers and employes.

The Review states editorially:

"Relations between employers and employes must be determined on the basis of mutual fair play and enlightened goodwill; there must be an adjustment of occupations to care for the returning of soldiers and at the same time accord adequate recognition of female labor in our industries; there must be a readjustment of tariff schedules to guard against an influx of hoarded goods from present enemy countries; the thousands of plants now busily engaged in the production of munitions of war must be adapted or readapted to their normal or newly developed peaceful pursuits. These are just a few of the hundreds of equally insistent questions that must be considered and on which the future permanent prosperity of this country must depend.

In approaching the problems of the reconstruction period we should not be carried away by optimistic hopes that they will not be of great importance or will somehow automatically solve themselves. Preparedness for post-war conditions is as important as for war. Nor must we work at cross purposes. We must co-ordinate our efforts as we now are doing, in order that we may achieve the greatest good for the greatest number. This evidently calls for a definite program of action on broad national lines and it is to lay down the groundwork for this that a national reconstruction commission is desirable.

The details of any national program must, however, be worked out by the industries themselves and in this connection the task of the electrical industry is a stupendous one.

The Naval Psychiatric Unit

ARE you temperamentally or otherwise unfit to become a wireless expert? Possibly so, but if uncertain on this point, you will soon ascertain your standing after joining the Naval radio school at Great Lakes, Ill., for they have inaugurated a Psychiatric Unit, the sole purpose of which is to determine the education, mental alertness and all-around qualifications of their students.

The examinations are under the supervision of Chief Yeoman Johnson and his specially trained staff of assistants, who give their students a thorough drilling on such general subjects as, reading, writing, arithmetic, ability to take dictation, the translation of their notes into long-hand, and such other general questions as seem applicable to a well-balanced radiotelegraphic expert. Of course, the primary object of the test is to eliminate men who apparently could not progress rapidly enough for the requirements of the government service.

The examinations of the Unit were evidently of great value, for it was found, after a sufficient number of cases had been investigated to determine fully the accuracy of the Psychiatric tests, that 95 per cent. of the men examined either progressed or failed in accordance with their previous judgment. Quoting a recent article in the school publication Radio Sparks:

"It was found that in practically all cases where the men were examined the men themselves were satisfied with the finding of the psychiatric unit and fully agreed to the transfer if it was suggested. In a few cases, however, individuals insisted that they were able to learn radio and requested that they be allowed to continue for a sufficient length of time to determine whether or not they could make satisfactory progress. In a number of these special cases the men actually did make good, but the great majority of them finally agreed with the examiner that they were not fitted for radio work.

"When it is evident that a man is not fitted for radio work, the psychiatric unit takes special pains to determine in what branch of the service the man belongs, and arrangements were made with the various departments needing specially qualified men, to transfer to them such men as seemed especially fitted for work in their department. This gave such good results that in quite a number of instances the heads of these departments informed the officer in charge of the Radio School that the Radio School was able to select better men for their departments than they were themselves, and this feature also added considerably to the good feeling existing among the men assigned to duty in the Radio School. They were thus assured of what is commonly called a 'square deal' and took the examination fairly and even enthusiastically."

Close to 25 per cent. of the men assigned to duty at this radio school are in this manner eliminated, the tests showing that they were inapt for radio work.

In fact, the success obtained at this training school has in no small measure been credited to the correct selection of the personnel by the Psychiatric Unit.

A similar procedure has been employed by the Marconi Institute for some years past. The students being queried on such general questions as "How far is the sun from the earth?" "What is the average time to take a train trip from New York to San Francisco?" "Name the seasons of the year in the zone in which your school is located and the approximate dates of their beginning and ending."

This test is followed by simple questions in arithmetic—division, decimal fractions and such other arithmetical problems as were deemed necessary to insure the students' progress. Such tests show to the student how little he retains in mind of the actual and fundamental facts of matters pertaining to every day occurrences and to say the least, they tend to sharpen his wits.

Our good wishes go forward to the Psychiatric Unit of Great Lakes for they undoubtedly have performed a great work for the government.

Book Reviews

Aero Engines, Magnetos and Carburetors. By Lieut. Harold Pollard. Cloth binding, 4½x5¼ inches, 84 pages. Macmillan. Price $1.00 net.

Those to whom the mere mention of the various parts of a gasoline engine are bewildering may learn from this little pocket volume what they are and how they function. While the book does not reach the proportions of a technical work on aero engines, it will serve adequately to introduce the subject in a reader's spare hour. In every sense it is a text for a beginner; easily understandable explanations of the general considerations are adequately illustrated by thirty-one diagrams.

Obtainable through the Book Dept., THE WIRELESS AGE.

Aeroplane Construction and Operation. By John B. Rathbun. Cloth binding, 5¼x8 inches, 415 pages. Stanton & Van Vliet. Price $2.00 net.

A compromise between the layman's books and highly technical airplane treatise has been arrived at in the preparation of this volume. Its principal feature is the text on calculations for surface, power and weight, although the aerodynamic principles and construction details are given considerable attention and are well illustrated. The volume follows the usual textbook form, first defining and classifying airplane types, applying aerodynamic principles to wing sections, discussing construction of these in detail and considering quite exhaustively fuselage and chassis construction. The factors of weight, balance and stability and head resistance are valued and power calculations made. A chapter is devoted to operation and training methods followed by a brief one on the characteristics of aeronautic motors.

Those who have had some technical education and are interested in the engineering phases of aviation will find the book of value. The trained mechanic and future designer are adequately served on the subjects of wing and body structure, and the author's expressed hope that "the book will serve to inspire the technical reader to deeper interest and practical research" in aeronautics should be fully realized.

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Aeroplane Construction and Assembly. By J. T. King and N. W. Leslie. Cloth binding, ox9¼ inches, 115 pages. Dunwoody Institute.

As its title implies, this book specializes in airplane rigging. The Curtiss machine is used to explain the principles of assembly and alignment, and is progressively considered from the time it arrives in a packing case until the running gear, wing and control surfaces have been assembled, attached, adjusted and aligned. The required inspection and preparation of engine and propeller prior to flight is then detailed and cautions and instructions for general inspection given. Materials and functions of the various structural parts are considered in detail and a final chapter co-relates the individual rigging problems by a concise explanation of the theory of flight.

As a means to a practical understanding of the work of the aviation mechanic concerned with the airplane structure's erection and assembly, the book is assured a distinct place in aviation literature.

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Practical Flying. By Flight-Commander W. G. McMinnies, R.N. Cloth binding, 5½x8¼ inches, 246 pages. Doran. Price $1.50 net.

As the three volumes just reviewed are concerned with the mechanics' problems in aviation, this book is almost entirely designed for the aviator. The practical considerations of flight is the author's subject, beginning with qualifications and causes of engine trouble, preliminary to a chapter on the governing principles which make for success during the first lesson in the air. Solo flights and the use of the instruments are then described, completing the preliminary stage. Map reading, preparation and airmanship in cross-country flying, successively follow. Advanced flying is then considered in many aspects: high altitude, acrobacy and air navigation at night being the principal divisions. A chapter on growth of confidence, from both instructor's and pupil's viewpoints concludes with a supplementary discussion of medical aspects and provision of suitable clothing. An appendix carries a glossary of terms and condensed hints for flying efficiency through elementary and advanced stages.

Sound advice and valuable hints on personal flying efficiency both for the beginner and the flier still under instruction but in more advanced stages are contained in generous profusion throughout the pages. Careful reading of the volume will undoubtedly improve the airmanship of nine out of ten pilots and certainly will enable the beginner to avoid the mistakes commonly made.

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The Shipbuilders' Blue Book. By Walter Kay Crawford. Cloth binding, 4x6 inches, 79 pages. Ocean Pub. Co. Price $1.50 net.

The definite announcements of the colossal shipbuilding program to be continued by the United States, adds special interest to this book. The men who are to engage in this industry have little to guide them on the assembly of the various steel plates of which a ship is constructed, and it is to the definition and explanation of the work of the shipfitter that this handbook is devoted. The special rules and requirements of this planning and assembly work are given, the problems of riveting and the approved methods are shown, the basic principles of ship construction being graphically presented by twenty drawings and simplified supporting text. It condenses the thirty years of Mr. Crawford's experience as a shipbuilder and, as information from a thoroughly practical man, will find a ready welcome among those who will engage in the construction of the new American merchant marine.

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Mahan on Naval Warfare. Edited by Allan Westcott, Ph.D. Cloth binding, 5½x8 inches, 372 pages. Little, Brown. Price $2.00 net.

One does not attempt to gild the lily bv saying anything in praise of the works on naval warfare of Rear Admiral Alfred T. Mahan; his writings are not only standard on the subject, but the leading expressions in that difficult field. It but remains, then, to note on the present edition that the editor, an instructor at the U. S. Naval Academy, has accomplished to entire satisfaction the concentration in one book of the basic opinions of the world's authority on sea power and naval strategy. Mr. Westcott has not condensed; he has selected from the many Mahan writings the best that value the influence of sea power, define the principles of naval warfare and apply the lessons of the past to the present and future. Thus the compact volume brings to the seafaring man a book easily termed indispensable to a full understanding of his task of assisting in safeguarding the shores of his country and his function on the wide reaches of the sea.

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Winning and Wearing Shoulder Straps. By Lieut. Col. Charles F. Martin. Cloth binding, 4½x5½ inches, 105 pages. Macmillan. Price $1.00 net.

Colonel Martin's little book is a study of the art of command, responsibilities of the army officer, the required efficiency and the psychology of leadership. The advice throughout is sound, and it is of a character that is perhaps best termed advisory. The heart-to-heart talk style of presentation give each point emphasized a "sticking" quality that may serve an officer through many trials long after the source of the knowledge is forgotten. To men still abroad who have the guidance of troops on irksome police duty its direct psychological analysis of the soldier should prove invaluable; and to the many officers who will return to civilian life but still remain on the reserve list, it will concrete experiences and analyze any errors in administration the source of which may not yet be clear.

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Do's and Don'ts for New Soldiers. By Major Harlow Brooks. Cloth binding, 4½x5½ inches, 83 pages. Macmillan. Price $1.00 net.

Another handy pocket book for soldiers on duty overseas during the aftermath period is met with in Major Brooks' text. Pertinent subjects are: police duty, care of the body, what to do when sick or wounded, what to study and remember, the attitude of the soldier toward civilians and when in conquered territory, military courtesy and customs of the service.

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A General's Letters to His Son on Minor Tactics. Cloth binding, 4½x7 inches, 95 pages. Doran. Price $1.00 net.

The anonymous author of this handbook observes a fact well known to officers of the regular establishment: that many men who are in other ways excellent instructors have not the facility for constructing problems with a point. So for officers following civilian pursuits except in emergency, he has done a distinct service in his twelve problems in minor tactics; with these as a basis, proper reformation may be looked for in the method of conducting officers' schools in the militia. The problems have a new pattern, and a very useful one because of entire applicability to actual combat. Too much stress, it may well be said, has in the past been given to the maneuver type of tactical exercise. Lamentably little time has been devoted to ranging for rifle fire, the importance of which is well emphasized in this work.

To illustrate the value of the text it might be remarked that the writer of this review, a typical civilian officer, set out to solve the problems before consulting the answers, with the following result: seven were solved correctly; four solutions were partially correct; one solution was entirely wrong. Yet the author's answers were obviously correct and led the reviewer to wonder how he could have failed of 100 per cent. correct solution. The obvious reason is that the type of problem was unfamiliar, just as would be the case in at least 90 per cent. of reserve officers otherwise well qualified for leadership.

The little volume is a necessity to militia officers who take their responsibilities seriously.

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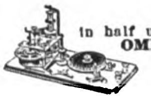

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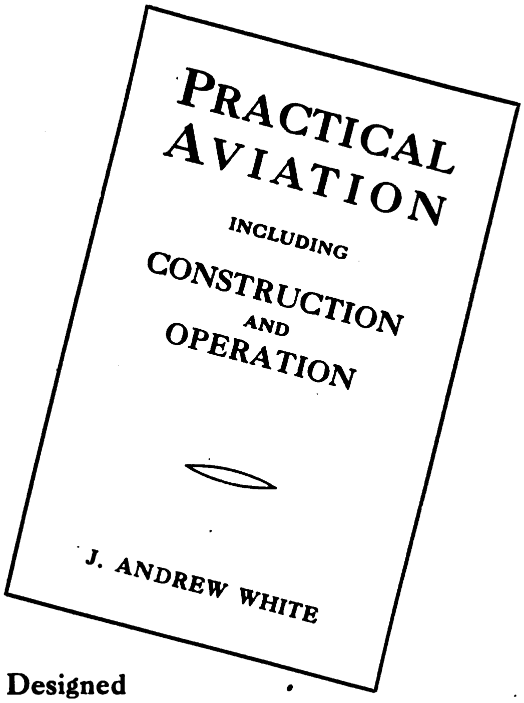

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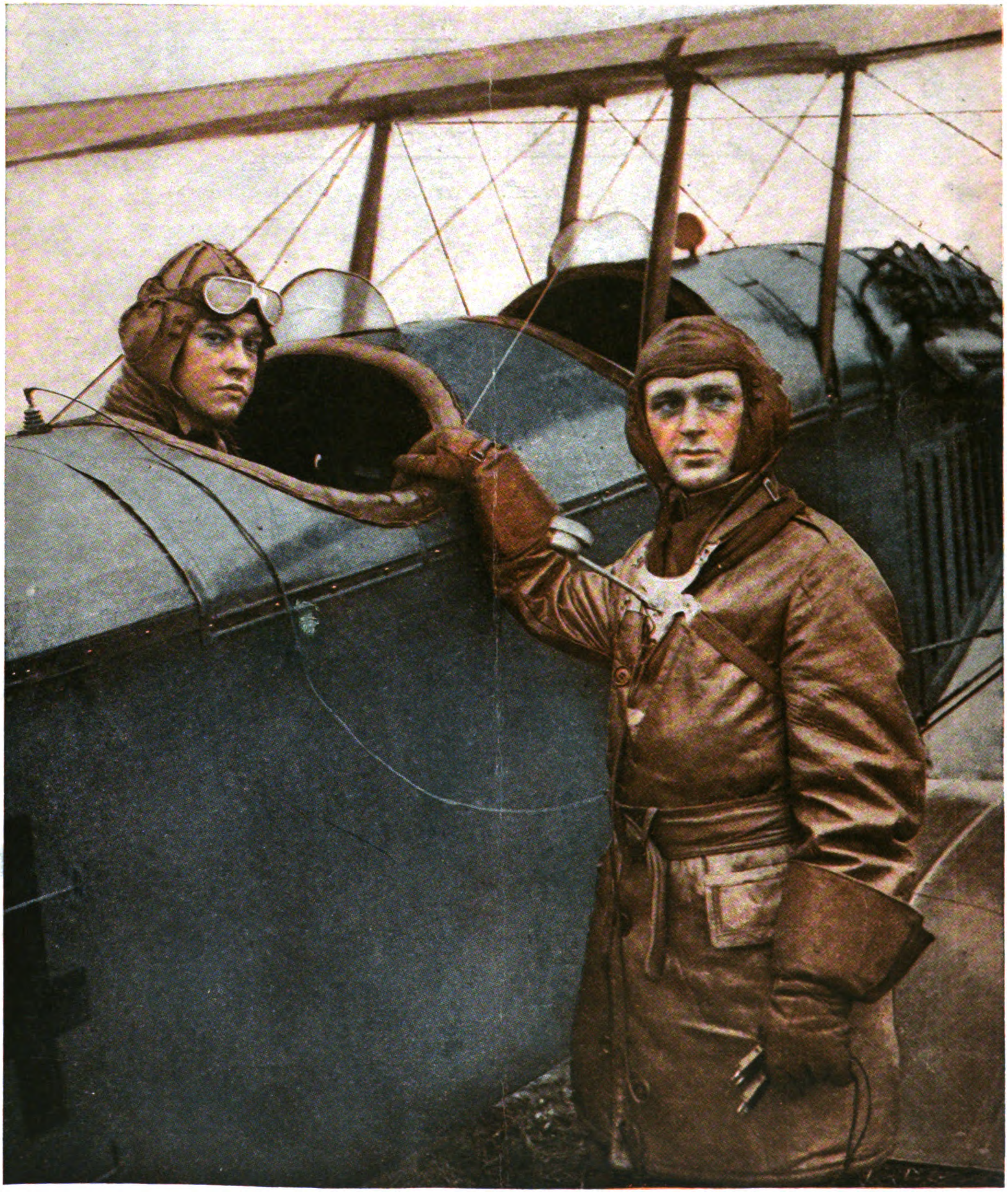

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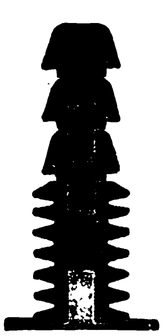
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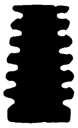
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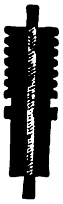
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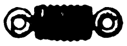
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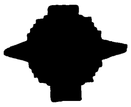
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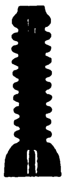
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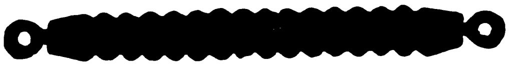
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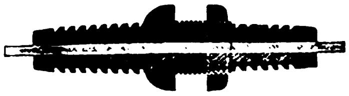
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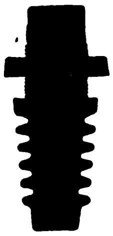
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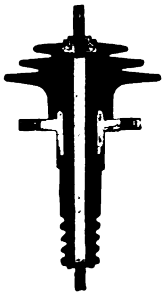
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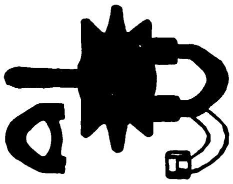
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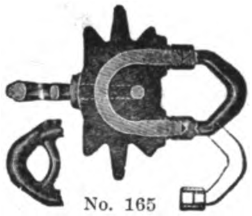
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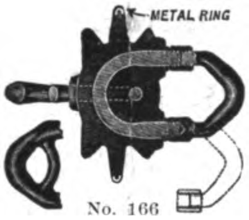

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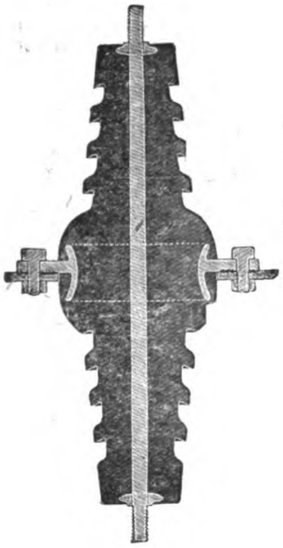
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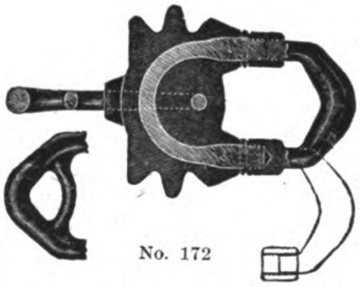
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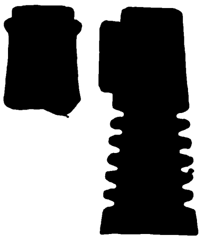
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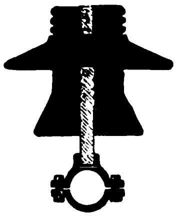
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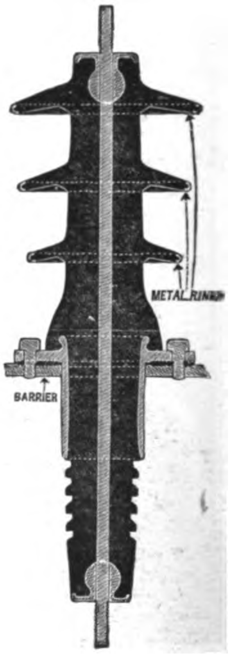

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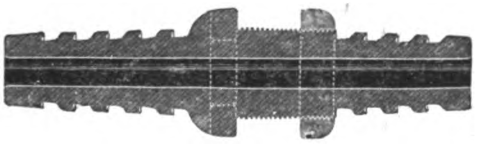
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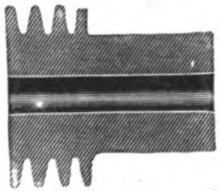
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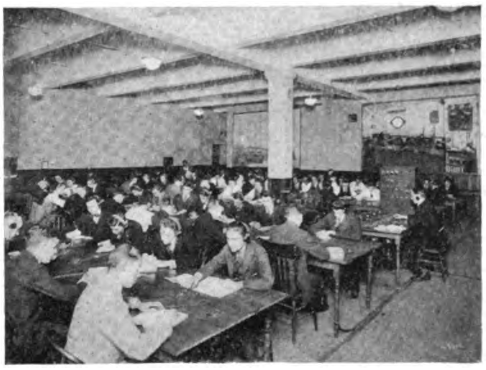

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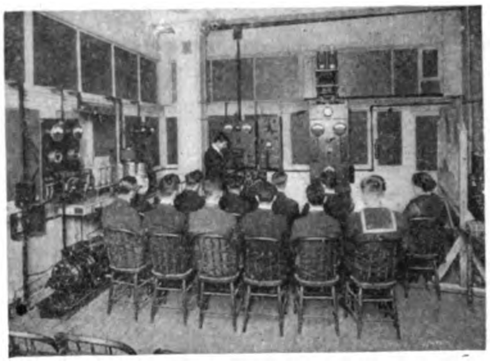

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The Wireless Age

Edited by J. ANDREW WHITE
E. E. BUCHER, Technical Editor

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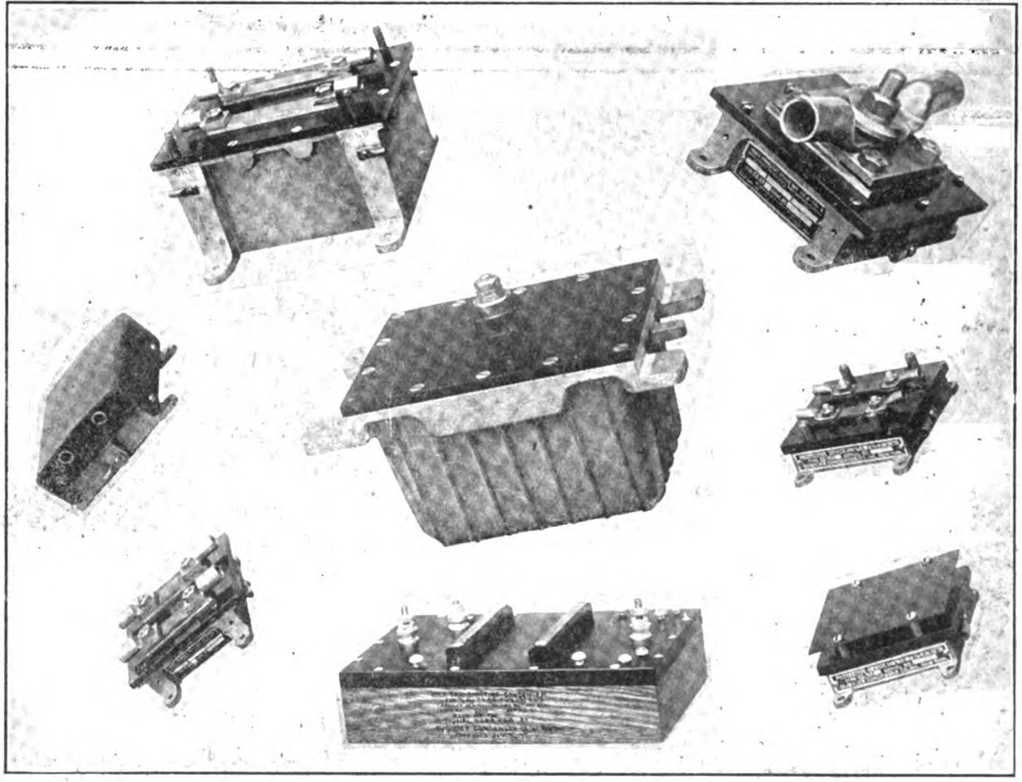

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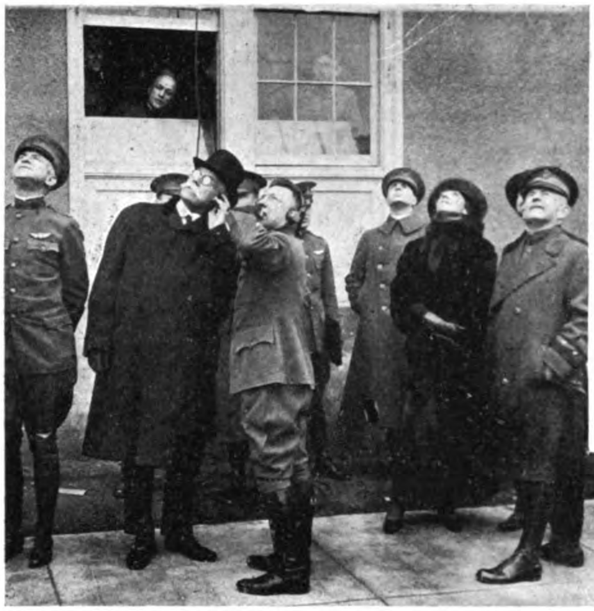
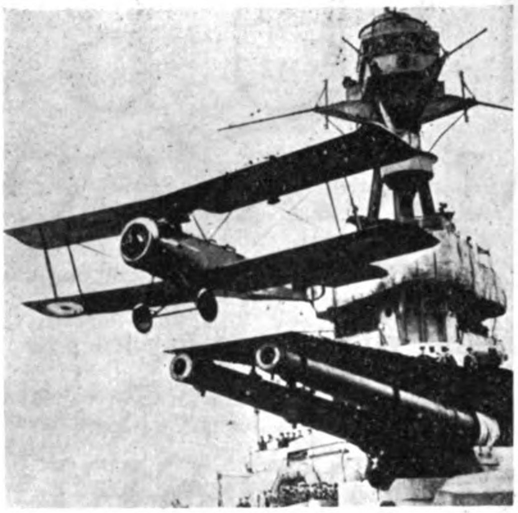
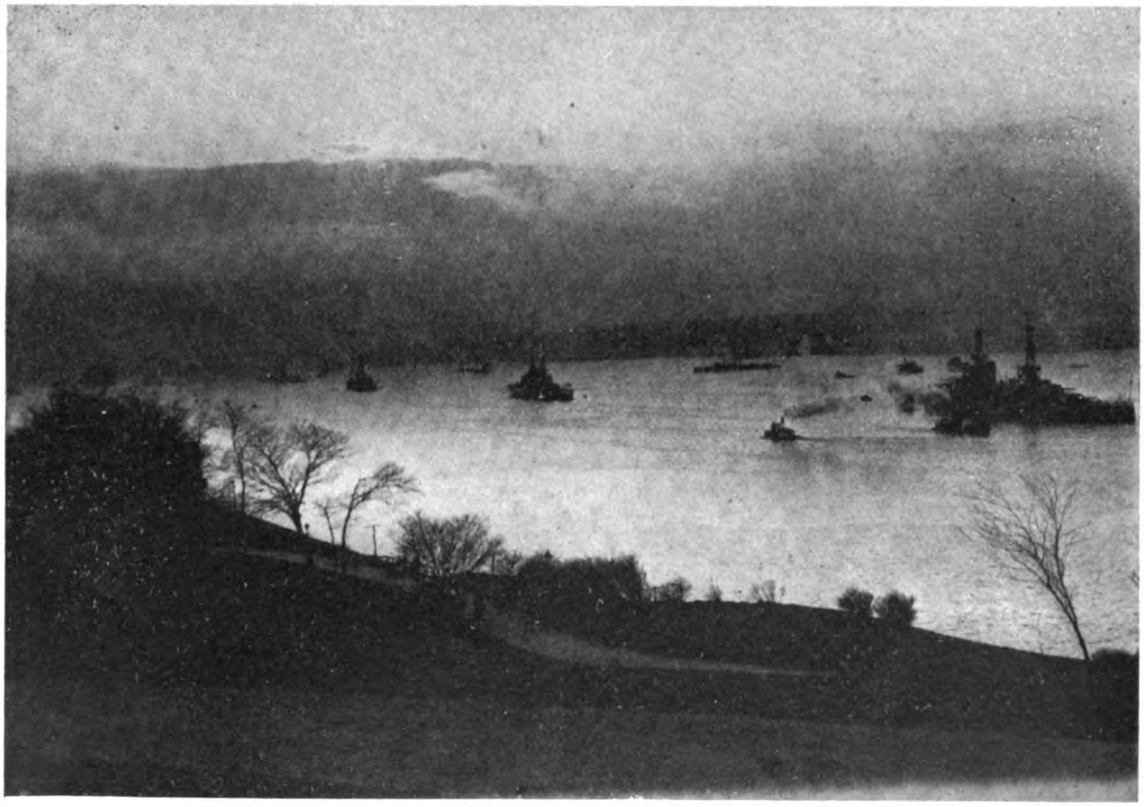




Above: How the naval air scouts were launched on their daily patrol missions in overseas waters

To the left: Colonel Culver directing by wireless telephone four army airplanes flying in formation over Washington. The planes were at a height of 2,000 feet. With Col. Culver is Senator Warren; General Kenly is at the right of the picture



Photos by Int'l.

When the battle fleet arrived in New York the first greeting was given by wireless telephone

Vol. 6. No. 5. February, 1919

THE WIRELESS AGE

WORLD WIDE WIRELESS

Another Five Per Cent Dividend for American Marconi

AT a meeting of the Directors of the Marconi Wireless Telegraph Company of America held at the offices of the company on January 14, 1919, a dividend was declared out of surplus profits at the rate of 5 per cent on outstanding stock. This return on the common stock is payable July 1, 1919, to stockholders of record at the close of business June 2, 1919.

The dividend is the third declared by the American Marconi Company, the first, 2 per cent, being in August, 1913, and the second, 5 per cent, paid six months ago, August 1, 1918.

Navy Announces Underground and Water Wireless

HOW underground and through-water wireless, or induction telegraphy, was put into practical use during the war was disclosed on January 11 by Navy Department officials, giving to the public another of its secrets carefully guarded so long as it might be of value to the enemy. This development originated in private research by James H. Rogers, a scientist of Hyattsville, Md.

In practical use the new system so far is employed only for receiving radio messages sent out from powerful stations in Europe. These are now being read at underground receiving stations in the United States.

In addition, it was revealed at the department, through an adaptation of the Rogers theory, submarines under water are intercepting radio signals sent from shore. With crude apparatus the scientist has succeeded in transmitting signals two miles from a submerged wire simulating a submersible.

Officials say it is possible, although not yet an accomplished fact, that ground or water sending can be developed to a considerable extent. They do not anticipate, however, that the present method of sending from high towers will be superseded, except for special purposes.

The theory most generally held until Rogers demonstrated the correctness of his views was that impulses hurled into the air from a radio transmitting station and deflected earthward became dissipated, as does lightning, when they struck the ground or water. The Maryland scientist, however, believed that the impulses flowed through the earth as through the air and that it was only necessary to trap and measure them in the ground.

Mr. Rogers had been at work on this theory before the United States entered the war and already had interested naval experts. He offered the results of his work to the navy without restriction, and when they were accepted after some demonstrations at Hyattsville, officials say, he was with difficulty persuaded to accept even remuneration for actual time given to co-operation with the government.

One of the first steps taken was the request of the Navy Department, under war legislation, that his application for patents be expedited. This was done.

Some of the main advantages of the Rogers system as developed so far, according to the experts, are almost negligible cost of construction, the intensifying of signals by pointing the sending apparatus toward the receiving station and reduction of static interference. Because of the latter advance the navy's receiving station at New Orleans, where communication with ships in southern waters swept by frequent electrical storms is maintained, uses the underground apparatus with marked success.

James H. Rogers and his new underground and undersea wireless used by the Navy during the war

In war a great advantage is that submarines receive messages while submerged. This is being done by wires trailing in the water.

Trans-Atlantic Radiophone When Peace Treaty Is Signed

WE will be talking across the Atlantic ocean by wireless telephone by the time the peace treaty is signed, according to Godfrey Isaacs, managing director of the Marconi's Wireless Telegraph Company of England. In a press interview he is credited with saying that as soon as war restrictions are removed, the development of wireless telephony will go ahead at a surprising rate.

"One day in the not distant future," he said, "we will walk about with wireless telephones attached to our bodies, and will be able to call up a friend, say from Picadilly Circus, who is flying somewhere. Or one may have a wireless telephone invitation from a friend flying in France to join him at dinner.

"It will not be very long before one will be able to sit at one's desk in London and speak to New York practically instantaneously. It will be quite as easy to speak with Paris, Rome, Amsterdam, Moscow, Sydney, Melbourne or New Zealand.

"We are arranging for large organizations whereby we shall always be in wireless telephonic communication with airships, to keep them informed concerning meteorological conditions."

Cheapening and quickening of news transit and expediting of trade and industry are among the immediate results predicted by Mr. Isaacs.

The Bump of Repentance
—*Nelson Harding in the Brooklyn Eagle*

War Ban on Wireless Messages Lifted

THE War Trade Board has lifted the ban on the use of the radio by commercial vessels in the Pacific and Atlantic oceans west of the fortieth meridian. This restores the use of the radio to conditions existing before the war.

The only restriction against its use now is in connection with the blockade, no communication with the Central Powers being permitted. The War Trade Board previously had rescinded its restrictions on use of the cables.

Relatives and friends of soldiers returning on transports from overseas may communicate with them by wireless and receive answers.

Messages may be filed at any telegraph office and will be relayed to a naval radio base.

Charges via New York are sixteen cents a word, including telegraph tolls. Persons so desiring may pay in advance for answers.

No message will be accepted until the ship for which it is destined has passed half way across the Atlantic.

Salary Increases for American Wireless Operators

THE special wage commission authorized by United States Shipping Board unanimously reached the decision that salaries to be paid wireless operators on vessels operated from Atlantic and Gulf ports, effective January 1, 1919, to be as follows: All chief operators, $110; all assistant operators, $85. There are to be no trans-Atlantic or coastwise bonuses, and no sliding scales.

Wireless Phone Commercially Practicable

JOHN C. PARKER, professor of electrical engineering of the University of Michigan, believes that it will be commercially practical to use the wireless telephone for long distance and middle distance calls.

"While a sending apparatus is expensive, and the cost of operation is greater than by wire, the total initial cost without wires will be so much less than that with hundreds of miles of wires that the wireless, as now developed, will be more economical," Prof. Parker says.

"It will be more dependable. Static disturbances have been practically eliminated, so storms will not interrupt service, whereas heavy storms put many wires out of business.

"For regular standard wire business, the radio or wireless telephone should supersede the telegraph and the wire telephone. It would be possible for one newspaper service, for example, speaking through one transmitter, to give news to thousands of different papers at the same time. It is impossible to compute the load this would take off the telegraph wires. The man talking through the wireless transmitter could be heard by as many persons as had receivers tuned up to the wave length the transmitter was sending."

Joseph H. Cannon, associate professor, said it would be entirely possible for the President of the United States to speak from the White House into a radio telephone and be heard by everybody in the United States who could get a receiver tuned up to his.

"On ocean and lake ships it would be entirely practical to install radio telephones, connected with wire telephones on the shore that would give direct, verbal communication between persons on shore and ship," Prof. Cannon says. "When we have airplanes carrying passengers between Chicago and New York the passengers could keep in touch with developments on the stock market minute by minute. The baseball or football enthusiast could follow his game play by play, as if he were in a club and the returns were coming by ticker."

Marconi Service for Passenger and Mail 'Planes

GODFREY ISAACS announced on December 18 that Marconi's Wireless Telegraph Company, of London, would outfit airplanes employed in air passenger and mail service with wireless and would supply operators in the same way as it now serves ships. It also is intended to receive regular reports of air conditions in different localities and to circulate these for the information of the pilots. As every airplane will have either a name or distinguishing number, it will be possible to send telegrams from any part of the world or from any ship to an airplane. It is intended that this organization will be ready by the time the peace treaty is signed.

Arrangements recently have been made for the erection of wireless stations in the extreme parts of China, one on the frontier of Cashmere and another on the Chinese side of Siberia. Mr. Isaacs has arranged with Handley-Page for the transport of the necessary machinery by one or more of his big machines. The journey inland will take two or three days instead of months.

War Radio Hero Found a Job Waiting

WEARING the Croix de Guerre with a palm, which had been pinned upon him by Premier Clemenceau of France, Sergeant Elias A. Kimball of Co. E, Second Telegraph Battalion, applied recently for a job at the Labor Bureau in the Hall of Records, New York.

"I've had enough of war; what I want now is work," Kimball said.

At Belleau Wood, he and eight comrades were operating a radio outfit when the Germans opened a barrage and the aerial was blown into No Man's Land. Six men tried to bring them back. They were killed. The Major in charge of the party crawled out, but was hit and incapacitated. Then Kimball wriggled his way forward and brought back the wires and the injured Major. For that he got the French War Cross.

Later, at Soissons, he won the palm by sticking to his radio apparatus during a heavy fire and a terrific electric storm. Lightning finally struck his mechanism and knocked him unconscious. When he recovered he was in a Paris hospital.

Sergeant Kimball got his job from the Labor Bureau.

Radio Essential Equipment on Modern Aircraft

SOME details of the development of the airplane radio telephone set which is featured on the cover of this issue were given by Major General George O. Squier, Chief Signal Officer of the Army, in a paper recently read before the American Institute of Electrical Engineers.

On May 29, 1917, the Chief Signal Officer called a conference in his office to set in motion the project of evolving a "voice command" equipment for airplanes which should meet all the severe requirements of the military service and which should be thoroughly standardized for quantity production. Speech was exchanged between airplanes twenty-five miles apart in October, 1917, and sample sets were sent at once to the army in France, for trial. Several thousand sets were ordered and have been completed and distributed to flying-fields here and to the Air Service in France.

The radio equipment consists of the vacuum tube transmitting and receiving set, and the special telephone transmitters and receivers. General Squier, referring to the latter, said: "Those of you who have heard the terrific roar of a Liberty engine will realize the difficulty of talking in an airplane in flight. The development of a transmitter which is affected by the human voice, and not by the enormously greater engine and wind noises, is one of the principal features of this set. Similarly, to shield the ears of the aviator from the same noises required a special combination of sound-insulating materials surrounding the telephone receivers and suitable for use within an aviator's helmet."

The antenna originally consisted of a flexible copper wire several hundred feet long, unreeled by the aviator and trailing almost horizontally behind the airplane. Modified antenna using much shorter wires fixed to the framework are now used.

The operation of the sets is extremely simple, all adjustments being made before leaving the ground. The only manipulation required of the aviator is that of the changeover switch to change from talking to listening.

Valuing the remarkable advances recently made in radio, General Squier said: "Commercial and military possibilities have, however, hardly been touched as yet. It is believed that radio apparatus soon will be as essential on aircraft as it now is on ocean-going steamships, and that its use will enormously increase the effectiveness of aircraft for all purposes."

Royal Society Chairman Recognizes Future of Wireless Press

IN a recent address on "Science and the Future," delivered before the Royal Society of Arts, in London, by its chairman, A. A. Campbell Swinton, interesting comments were made on the recent achievements and new possibilities of wireless communication.

"One matter, however, is within public knowledge," he said, "and that is the increased and still increasing amount of news that we get in the papers that appears under the heading of 'Per Wireless Press.' Indeed, wireless telegraphy appears to be developing at last in what has always appeared to me to be its proper field, which is not so much to communicate between one individual and another, but rather for the communication of intelligence broadcast over the earth. No doubt maritime wireless communication between ships, and between ship and shore, hitherto its most useful application, is another case altogether, and supplies a want that telegraphy by wire cannot meet at all. With this we are already familiar, while the use of wireless as a voice that can speak simultaneously to points on every portion of the earth is in some ways a more novel proposition.

"No doubt some persons who had private wireless stations of their own before the war, were used to getting time signals from Paris from the Eiffel Tower, and from Nauen in Germany while a few of those who had mastered the difficulties of reading the Morse alphabet by ear, were able to decipher weather reports from these places as well as from our own Admiralty, in addition to general news from Poldhu in Cornwall, and from one or two other large stations.

"What I have in my mind, however, goes much farther than this. In London tape and column-printing telegraph instruments operated by wire, that record sporting, parliamentary and general news, have long been familiar objects in clubs and hotels, and have become a portion of our daily life. Now there is no reason at all why similar printing instruments, which he who runs can read, should not be operated by wireless means, not only in London and other large cities, but throughout the country, or even throughout the world. Special transmitting stations using different wave-lengths could send out the messages, while separate printing machines, tuned each to respond to the wave-length of a particular trans-

This is my job / and I am going to hang on to it
Thomas '18

The girl he left behind him
—*Thomas in the Detroit News*

mitter, at each required point, would receive and record them. No connecting wires, costly both as regards first expense or as regards upkeep, would be required, but only suitable aerials at each transmitting and receiving station.

"Some regulations would be necessary to prevent interference, and as wireless waves, traveling as they do through the ether of space at the enormous speed of 186,000 miles per second, recognize no international boundaries, they would have to be universal. Thus arises a fitting opportunity for the league of nations. For the distribution of news to the press nothing could be better or more economical, while there is no reason why clubs, hotels and private houses everywhere should not also be thus supplied with the latest intelligence. For in wireless telegraphy it costs no more to send signals to a thousand receiving stations than to a single one, and there is practically no limit to the number of stations that can simultaneously receive signals from a single transmitting station.

"To some, this sketch of the universal distribution of news to all and sundry may appear fantastic, but it is not really so at all; for at any rate as concerns an area no larger than Western Europe and the British Islands, it is well within the range of practicability at the present time, and only requires a little working to arrive at the best arrangements."

Radio Service to South America an Imperative Need

IMPERATIVE need of direct cable connections, supplemented by radio service, between the United States and South America as the first and most important step in the development of relations between the American continents, is emphasized in a report made to Secretary Daniels by Captain C. T. Vogelgesang, just returned from Brazil as chief of a naval mission.

"The field is at this time open to energy and enterprise," the report says, "and if United States capital, backed by a strong and enduring policy of Government support, does not avail itself of the golden opportunity that is now presented, foreign capital will control and we will not have established that community of interest that Brazil looks for in her relations with us."

Wireless to Relieve European Cables

ORDERS were issued by Postmaster General Burleson on January 4 for routing by wireless all Government cable messages addressed to Europe unless specifically stamped "not to be sent by radio." The order does not apply to private cable messages, those sent by individuals or business firms, and does not apply to confidential Government messages.

Routing of Government messages by radio wherever possible was determined upon because of congestion of the cable lines.

Both the War and Navy departments have been asked to co-operate in radio use and to instruct officers in Europe to use radio for official messages wherever possible.

Fiji Islands Connected with New Zealand

A WIRELESS station has been established at Avarua, the principal town and port of Rarotonga, that now practically connects up a chain of wireless stations between the Fiji Islands, Tahiti and Rarotonga with New Zealand.

Service to Hawaii and Japan Resumed

AFTER suspending ten months, commercial radio communication between San Francisco, Hawaiian Islands and Japan was resumed December 19 at midnight.

Lieutenant-Commander C. R. Clark, Pacific Coast communication superintendent, stated Government stations will handle the traffic. The San Francisco station is at South San Francisco and the Hawaiian station at Pearl Harbor. The Japanese station at Funibashi is controlled by the Japanese Government.

Under the Government plan, messages for Japan will be received only from San Francisco and bay cities. Messages may be filed in any part of the United States for the Hawaiian Islands. Western Union offices will receive messages for delivery to naval stations. Due to congestion and the limited service, only full-rate messages will be accepted. All messages will be subject to censorship. Information concerning the certain codes which may be used may be had from the office of the Chief Cable Censor.

Before the war the Marconi Company handled commercial radio traffic to Japan. This service was suspended February 21, this year.

France to Get American Overseas Station

THE French government is expected soon to take over from the American Navy what will ultimately be the most powerful wireless station in the world. It is located at Croix d'Hins, near Bordeaux, and will consist of eight towers, each more than 800 feet high. It will be able to transmit messages not only to all parts of the United States, but perhaps even to Honolulu. Construction was begun a few months ago by the American Navy for the American Expeditionary Forces, with the understanding that ultimately it should be ceded to France.

Naval War-time Radio Included 4,000 Stations

"NAVY NIGHT" in the thirty-ninth annual meeting of the American Society of Mechanical Engineers was signalized by two events of more than usual timeliness and popular news interest. Before an audience which filled the auditorium of the Engineering Societies Building, in New York, Lieutenant Commander William L. Cathcart, U. S. N. R. F., lectured on "The Achievements of Naval Engineering in the War," with special reference to the Bureau of Steam Engineering of the Navy

Recounting the achievements of the electrical division, Commander Cathcart said:

"Under the supervision of the radio division there are now more than four thousand radio installations on board vessels flying the American flag. The bureau's direction," said Commander Cathcart, "extends similarly to fifty naval radio coastal stations and seventy-five commercial coastal stations in this country; to others in the West Indies and the Canal Zone, in our island possessions, and Alaska and Vladivostok in the Pacific, and finally to one now building for us at Bordeaux, in France, which will be the most powerful wireless station in the world.

"Communication between Washington and Russia will be made through the establishment of the Vladivostok station, now nearing completion. Our communications with China are through Cavite, and our Asiatic fleet to the United States Naval Radio Station at Peking."

Amateur Radiotelegraphy of the Future*

By Alfred N. Goldsmith, Ph.D.

Director of the Radiotelegraphic and Telephonic Laboratory, College of the City of New York

EDITOR'S NOTE—The author advocates operating all amateur radio stations of the future on sustained waves between 100 and 300 meters. He points out the desirable results of such a change, including a forty-fold increase in the number of stations operating within a given zone without interference, together with the immediate possibility of radio telephony.

I AM compelled by circumstances not to describe the actual construction of any particularly desirable transmitter and receiver. So detailed a prophecy as to the future of amateur radio communication seems to me ill-advised and calculated to do more harm than good. I prefer to indicate a line of future development, of a radical but practicable type. In so doing, it is my hope that an impetus will be given toward the development of the necessary equipment, so that those parts thereof which are now existent will be supplemented by the remaining new portions of the apparatus.

It is evident to even the most casual observer of radio telegraphy on a commercial scale during the last fifteen years that the tendency has always been strongly toward the use of sustained or "undamped" waves. Starting with the old-fashioned "spark-in-antenna" type of set, with its almost incredibly high damping and equally incredible capacity for the creation of intolerable interference with the work of other stations, the art progressed first to the inductively coupled stationary spark set of the old "United Wireless" type. Later came the modern quenched spark sets, these radiating waves of a damping of the order of 0.1. Were it not for the absurd regulation which practically places all ship and shore stations on a single wave length of 600 meters, these quenched spark sets would probably give a good account of themselves in the way of reducing interference. As it is, however, the full use of the available wave lengths is much restricted. Certainly it is to be hoped that in this, as in many other particulars, the present unwise radio regulations will be drastically amended.

THE SUSTAINED WAVE AND THE BEAT RECEIVER

But the evolution of the commercial transmitter has gone even further. There exist to-day at least three different types of fairly high-power sustained wave generators, namely the Poulsen arc, the vacuum tube oscillator, and the radio frequency alternator. All of these are in actual use, the first and third preponderating at present. With the advent of sustained waves, the receivers employed had to undergo fundamental changes. A whole series of new devices were evolved for sustained wave reception, notably the tikker, the tone wheel, and the beat method of reception. It is on this last method that I would center the attention of the reader. For it is my belief and hope that the amateur of the future will work with short sustained wave transmitters and beat receivers. In that direction I see really unusual opportunities for the earnest and ambitious worker.

Of course, the tendency toward low damping in amateur transmitters and receivers is very marked, quite apart from the 0.2 decrement regulation of the Government. Many amateurs are using quenched, or rotary synchronous, or non-synchronous gaps, and are doing work on low damping. The attempt to reduce the decrement of the receiving set is equally well marked. It only remains to carry this tendency to its ultimate, desirable, and logical conclusion.

The evils of high damping are very obvious, yet a brief calculation may not be amiss. Suppose that the decrement of the spark transmitter is 0.2 and that the decrement of the receiving set is also 0.2. Suppose further that the wave length is 150 meters. The question is: how far must the receiving set be detuned so that the signal strength is reduced to one-half? A simple calculation will show that a change in wave length of 10 meters is sufficient. That is, if we assume that we can read a message through interference of half its strength, a receiving operator could read at will any one of three stations at 140, 150, or 160 meters respectively. This is also on the assumption that the three stations come in equally loudly at resonance. Unfortunately these conditions are not always realized in practice, and if one of the three interfering stations should happen to be exceptionally near or exceptionally powerful, its interference would be difficult if not impossible to overcome.

OPERATING 400 STATIONS WITHOUT INTERFERENCE

I believe that the basis of decrement and ratio of desired-to-undesired signal given above is a fair one for comparative purposes. If so, we could not have more than about 10 stations working between 100 and 200 meters without causing serious interference. And this, too, under the most favorable conditions of equal-powered stations at equal distances from each other. The present-day excessively difficult conditions in thickly amateur-populated districts become immediately explicable on the above basis. It is clear that a radical change is needed so that every amateur can be reasonably secure from interference. It is for this reason that the sustained or "undamped" wave transmitter and beat receiver are advocated.

Fortunately enough, the beat receiver is particularly well suited to use at the short waves which are favored by the amateur. Interference is much less with beat receivers on short waves than at the long waves used by commercial stations. The following calculations will show this point clearly: Let us consider a large commercial station working, say, at 10,000 meters. This corresponds to a frequency of oscillation in the antenna of 30,000 cycles per second. If we receive this on a beat receiver, e.g., the ultraudion or one of the well-known Armstrong circuits, the receiving audion must be producing oscillations about 500 cycles more or less than those of the incoming wave. In this case, that frequency would be either 29,500 or 30,500 cycles per second for the local vacuum tube. It is found that the beats become quite faint and practically inaudible when we get more than 3,000 per second of them. That is, the range between 27,000 and 33,000 cycles per second must not be encroached on by an interfering wave. If it is, we shall get audible beats and interference between the desired and the undesired waves. Consequently we tie up the entire range of wave lengths between about 9,100 meters (corresponding to 33,000 cycles) and 11,100 meters (corresponding to 27,000 cycles). Stations must lie about 9 per cent apart in wave length at 10,000 meters for perfect beat reception. Thus, between 10,000 and 20,000 meters, only about 6 or 7 stations could work successfully on this basis. When we go down to 200 meters wave length (corresponding to 1,500,000 cycles), we find a much more favorable state of things. The limits of interference now lie between frequencies of 1,503,000 cycles and 1,497,000 cycles. These correspond respectivly to 199.6 meters and 200.4 meters, and are only 0.3 per cent apart. We will tabulate these and a few other results for comparison.

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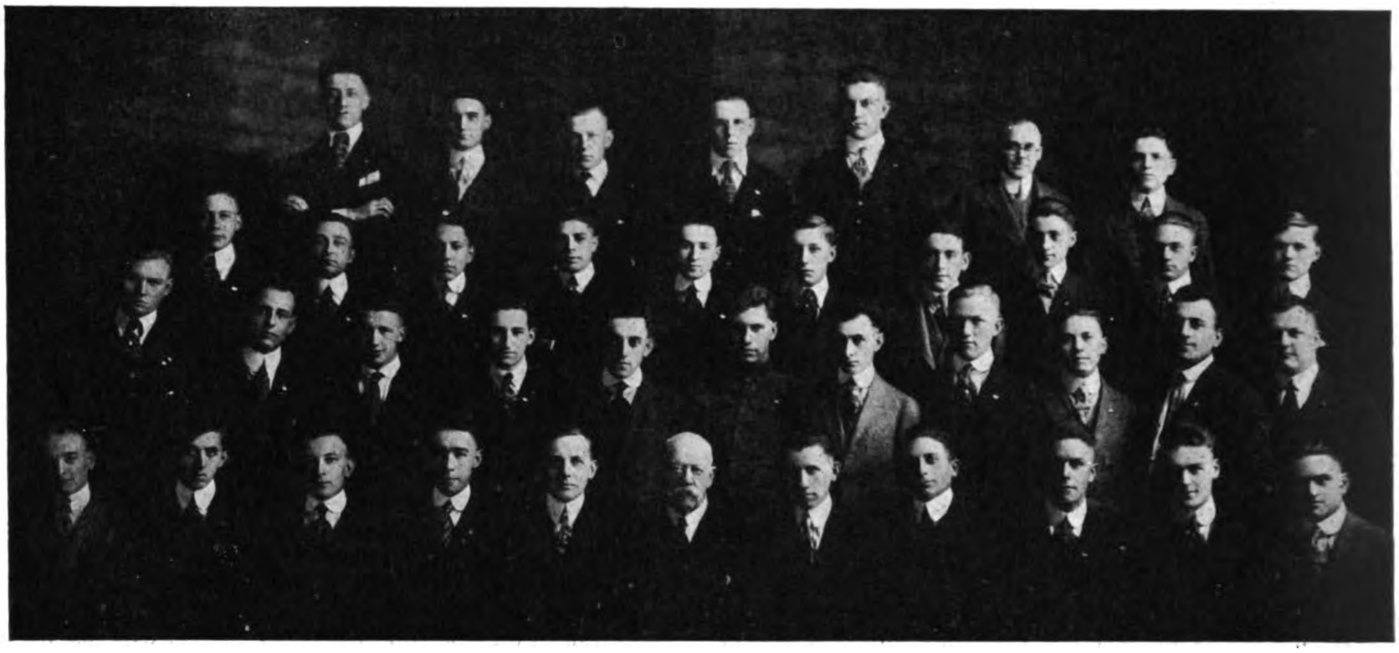
*Abstracted from a paper prepared for the Radio Club of America, 1916.



Hundreds of students similar to this radio and buzzer class at the St. Louis University are being prepared, at the various schools throughout the country, to operate the new devices in wireless telegraphy and telephony developed during the period of the war

Wave Length	Nearest Usable Wave Length	Per Cent Change
10,000 m.	9,100 m.	9.0
300	299.1	0.3
200	199.6	0.2
100	99.9	0.1

Consequently we reach the astonishing conclusion that under conditions comparable to those mentioned previously, *amateur stations (using sustained wave transmitters and beat receivers) might be as many as* 400 *in number between* 100 *and* 300 *meters without interference!* It will be noticed that I have stretched the amateur wave length range to 300 meters, which is a change that I favor under the conditions mentioned, since interference would then be so markedly reduced.

Arc and Vacuum Tube Transmitters

I need hardly point out at length the desirability of having 400 stations in the same amateur zone working without interference as compared to a possible 10 under present conditions. The improvement speaks for itself.

It is necessary to go further, and point out the actual methods which will probably enable the amateur to carry out so admirable an improvement. To begin with, he will need for his transmitter a sustained wave generator of extremely constant frequency or wave length. Also, it should be steady and silent in operation. Although I have repeatedly drawn 10 or 20 watts at 200 meters from small Poulsen arcs on 220 volts direct current by a simple enough method, I cannot recommend the arc for the desired purpose. It is not sufficiently constant in either wave length or current output for the purpose. It may be possible to improve it eventually, but, so far as I know, it is not a very satisfactory device at 100 or 200 meters.

It is probable that Chaffee arc sets somewhat like those described by Mr. Bowden Washington in the August, 1916, issue of the Proceedings of the Institute of Radio Engineers would be satisfactory for the purpose if the "inverse spark frequency" were painstakingly and accurately adjusted. I regard this as a highly profitable direction for investigation since the Chaffee arc is a simple and reliable device, and is well suited to amateur purposes. In its most recent forms, with the hydrogen tanks eliminated and alcohol vapor substituted, it seems to be remarkably well adapted to work from 100 to 300 meters with a steady sustained wave, suited to beat reception. I recommend experimentation and perservering tests with this most promising device. In working with it, attempts should be made to keep the running voltage as low as possible.

If one is content with low power and somewhat unusual equipment, the large vacuum tubes form an alternative source of steady oscillations of constant wave length. It is not excessively difficult to cause such bulbs to produce oscillations corresponding to 200 meter waves, particularly if high vacuum bulbs are used. It is to be hoped that these bulbs will be produced for the amateur market in form suited for both filament lighting and electron current supply from ordinary 110 volt D.C. power lines. That is, either a long 110 volt filament or a low voltage filament with series resistance should be used. Furthermore, the 110 volt supply should be also used in the plate circuit either directly or with a potentiometer. This double use of the 110 volt supply is quite possible, and has indeed been already accomplished by one of the best versed experimenters with such bulbs. The simplicity of such an arrangement is considerable, since one needs merely plug into any 110 volt socket to start the outfit operating. If alternating current only is available, rectifiers of some sort (e.g., hot filament vacuum rectifiers of the Fleming valve or kenotron types) become necessary.

AVOIDING CAPACITY CHANGES IN TUBES

At least one advantage in the use of the vacuum tube for transmitter is that the same bulb with a slight change can be used for the receiver. There should be simultaneous power reduction and wave length change by means of quick-acting switches. In this connection, an increasingly well-known difficulty with very short wave beat receivers may be mentioned. Particularly, when using the vacuum tube in beat receivers, the capacity in the various circuits at 200 meters is extremely small, and may be only the internal capacity of the tube itself. Consequently bringing the hand near any unshielded condenser causes a huge percentage change in capacity because of the capacity of the body, and the tuning (which is extremely close and delicate at best) is completely thrown out. It will almost certainly be necessary for really reliable operation to enclose the entire receiver, and for that matter the transmitter also, in a grounded wire netting screen. Any handles for adjustment must come through small holes in this screen or else be operated by means of soft iron attachments on the handle and small permanent magnets outside the screen.

There is a curious type of interference which will arise when two sustained wave amateur stations get too close together in wave length. It is familiar to those who have occasionally heard Nauen on 12,800 meters interfere with South San Francisco, the latter being also a sustained wave station. This is "beat interference," and results in the clear beat tone being heard whenever the waves from both the interfering stations come in. It is an annoying form of interference but can be avoided among amateurs with very slight trouble.

THE FIELD FOR THE AMATEUR RADIOPHONE

Another great advantage of the sustained wave transmitters which I have been advocating for all amateurs is that their long-desired goal of radio telephony becomes immediately accessible. All that is necessary is an ordinary telephone transmitter placed in the antenna, for example, with Chaffee arc sets or vacuum tubes; or used as a trigger control in any one of a number of interesting ways with the tube oscillator. I need not dwell on the additional value to the amateur of a combined radiophone and radio telegraph set, which is exactly what these sustained wave transmitters practically are. When used for radio telephony ordinary detector reception is possible, and in some ways preferable, to beat reception. Even supposing that these stations are received on ordinary crystal or vacuum tube detectors, there can be as many as 40 operating simultaneously without interference between 100 and 300 meters. Furthermore, they will not interfere at all with the hundreds of other sustained wave, beat received radio telegraph stations in the same zone.

HOW SPARK SETS HANDICAP SUSTAINED WAVES

There is one matter of the utmost gravity in connection with the suggested proposal of sustained wave telephone or telegraph transmitters combined with beat receivers for amateurs. And that is the absolute necessity, if the desired results are fully to be achieved, of having *all* amateurs working in this fashion. Every old-fashioned spark transmitter in a given zone will render its 20 meter range of wave lengths practically unusable by the more modern and highly efficient sets. So that only a few amateurs of the older type in any given zone would practically wreck all good work, even if they had the best intentions, which latter might not even be the case. It would be the intrinsic clumsiness of their apparatus which would be to blame, exactly as would be the case in a musical competition between a violin and an automatic rivetter.

REMOVING THE "JAMMING" BUGBEAR

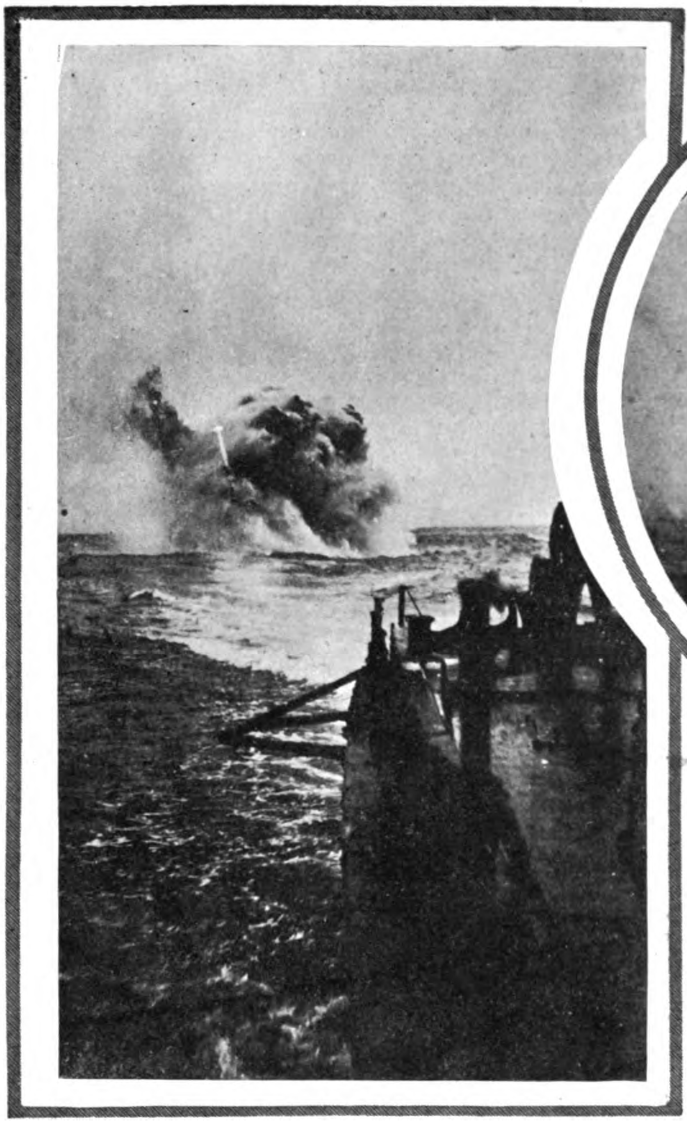
Since this is therefore a great advance, calling for the simultaneous co-operation of *all* amateurs, I suggest most earnestly that leading and influential amateur organizations, begin an educational and legislative campaign in this direction. It would be well to appoint a *Committee on Amateur Stations,* the duty of which Committee should be the spreading of the most modern and advanced ideas as to station construction and operation. Needless to say, the paramount function of this Committee would be to prepare the way for the great forward step to sustained wave transmitters and beat receivers. The publishing of suitable literature explaining simple, practical ways of getting the desired results can be to great advantage left to such a Committee. Furthermore, the drawing up of a program for suggested legislation along these directions and the enlisting of amateur and public support for such measures would also be a function of the Committee.

In this way, every amateur would be given much widened opportunities, and the advanced worker would be protected. Furthermore, even the beginner would be much assisted by the removal of the bugbear of everlasting "jamming." A campaign for the new type of amateur sets would therefore be a direct contribution to the spread of scientific knowledge over the entire country and an increase in public interest in the radio field. I need hardly say that this is the most basic and fundamental type of real national preparedness, and that no greater stimulus to national progress exists than awakened interest in science and scientific methods.

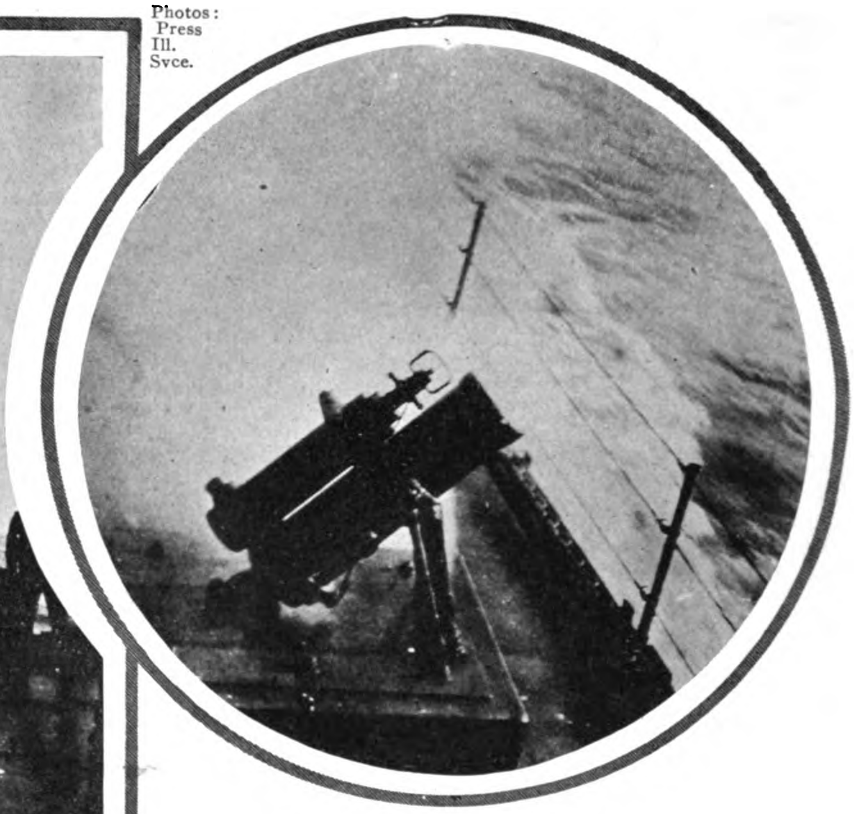
Suggestion for Prize Contest April Wireless Age

We will pay the usual prizes of $10, $5 and $3, in addition to our regular space rates, to the three contributors who send us the best manuscripts on the following subject:

What, in your opinion, is the most efficient receiving set for amateur wave lengths, and what should be the dimensions of the antenna and the tuning coils for best results?



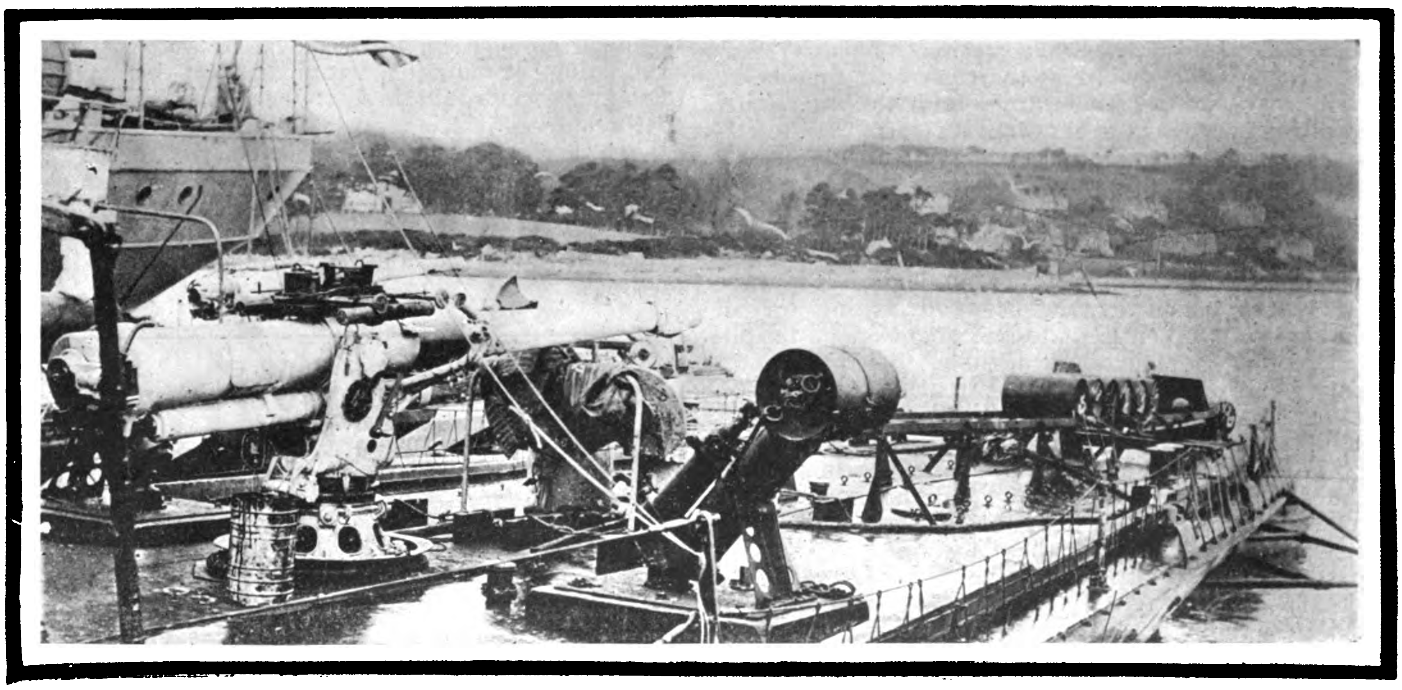
Photos: Press Ill. Svce.



"Ash Cans!"

The Depth Bombs Which Beat the Submarine

These photographs are the first which the Navy has released for publication showing the depth bombs which American gobs insistently termed "ash cans"—for the duration of the war. The view in the upper circle shows the depth mine gun in action; the surface view of the finish of a Hun submersible shortly afterward, appears on the left



Tranquillity graces this deck scene of an American fantail lying alongside the mother ship Melville, her mission accomplished. A depth charge is here resting on its gun; nearby is a rack capable of holding 44 additional "cans"

My Experiences in the War

First Installment of the Personal Narrative of a Pioneer in Aircraft Wireless Who Was Wounded and Captured In the Attempt to Stop the Hun Invasion

By Captain Gordon Adams

South Lancashire Regiment

Capt. Gordon Adams

DURING the first year after I had passed through the Royal Military College at Sandhurst, and obtained my commission as a Second Lieutenant in the English Royal Army, I found that the whole of my spare time was engaged in learning actual military work; but at the end of that period, in 1908, my regiment moved to a small village in Ireland, and having successfully passed my examinations for promotion to the rank of Lieutenant, I had a considerable amount of time at my disposal for working at subjects other than of a pure military nature. From this time on, I devoted every possible moment that I could spare from my military duties to the study and application of mathematical science.

Starting off with astronomy, I went all through the subject of navigation, both theoretical and, as far as possible, practicable. This led on to surveying, and so on to optics and mathematical physics in general. Every new field that opened up demanded an increased knowledge of mathematics and I, therefore, had to work away solidly at that which is the absolutely indispensable tool in the tackling of any branch of science.

In 1910, I was made musket instructor to my regiment. Then I found numerous opportunities for applying the knowledge which I was gaining in addition to my professional duties. During my annual leave I made up the practical part which I was unable to work at while with my regiment through lack of instruments and other facilities. On these occasions I generally managed to get what I wanted in London or Cambridge Universities.

In May, 1912, the British Government decided to create the Royal Flying Corps, consisting of a Naval and a Military wing; in the autumn of that year the Central Flying School was inaugurated for the training of Naval and Military airplane pilots. Early in 1913 I sent in an application to join the R. F. C. and was very fortunate in having my application accepted within a very short time.

In those days the government required all officers to take their Royal Aero Club certificate at their own expense at a civilian flying school before proceeding to the Central Flying School. Once accepted as a Military Pilot, however, expenses were refunded. There were four flying instruction grounds then in existence. I selected Hendon (Brooklands, Eastbourne and Salisbury Plain being the other three). At Hendon there were four main schools, the Graham-White, the Bleriot, the Caudron and the Deperdussin. I chose the Caudron. The Caudron machine was a single seater tractor, with a 35 h.p., Y-type Anzani engine. It had no ailerons, the lateral control being effected by wing warping. It was unique in its construction; for though a tractor machine it was built with tail booms exactly like a machine of the pusher type. The pilot sat in what looked like a small cockle shell.

In the Caudron School, as in all other schools using single seater machines, the instruction was of the "Fly or Die" type. You were given a machine, and after a few explanations as to what to do, you were told to "push off" and taxi the machine about the ground, but after acquiring more confidence the throttle was opened until flying speed was reached; then a small drop was executed which usually terminated in a somewhat abrupt "alterissage." These hops were gradually lengthened until the pupil was able to make an ordinary straight flight.

When I did my first drop, I had never been up as a passenger, so that it was the first time I had ever lost touch with the earth. There is no question that the sensation embraced, for me, more than mere novelty. From straight flights the pupils went on to turns, until eventually the standard required for the R. Ae. Club's certificate was reached. The test for this certificate was to fly 5 figures of eight at a height of not less than 150 feet, and then to land. After touching the ground, with the engine switched off, the machine had to come to a standstill at a distance not greater than 50 yards from a given point. This performance had to be gone through twice.

Owing to the instability of machines in those days, no instructional flying was carried out except when the weather was absolutely dead calm. This entailed getting up in the morning at dawn, the hour when the air is usually calmest.

On the morning I was going to take my Aero Club certificate I started off full of confidence, but after doing a half-circuit of the Aerodrome, and when I was only about 15 feet off the ground, my engine began to miss badly. I found myself up against the proposition of either charging straight into a shed or attempting to turn. I tried the latter, sideslipped and crashed. . . . .

No other machine being available for me to have another try on, I had to wait until my arrival at the Central Flying School to take my "ticket."

Just as the training methods were widely different from those of the present day, so did the early aeroplanes reflect the inefficiency of aeronautics five years ago. The equipment available for flying instruction was uncertain and diversified. In addition to the schools at Hendon there were several manufacturing firms experimenting with different types of machines. One of these was the Breguet. This machine was peculiar in many ways. In the first place, most of the spars were steel instead of wood. It had only one row of interplane struts, and when stationary the trailing edges of the wings were very flexible and hung down in festoons. The wings were warped for lateral control by the feet, the steering being done by a wheel. The tail and rudder were two flat planes fixed at right angles to each other, the whole being attached to the end of the fuselage by a universal joint. The result was that the tail or elevator and the rudder could not be

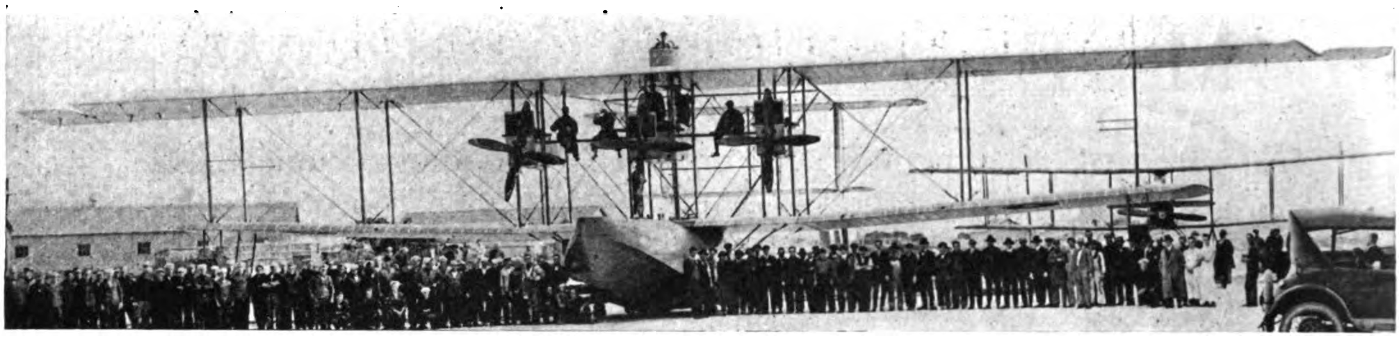


Photo by Int'l

This giant American hydroplane, which carried fifty passengers in a flight at Rockaway Beach, N. Y., offers a striking contrast to the early machines which Capt. Adams describes. It is propelled by three Liberty motors developing twelve hundred horsepower and producing a speed of eighty miles per hour

moved independently of one another. On one occasion when a Frenchman named Collardeau was flying the machine, the universal joint gave way and the whole contraption fell off in the air.

But even then, a lively discussion was being carried on about attempts to fly the Atlantic. Lieutenant Porte, I recall, was at Hendon at that time flying a 100 h.p. Anzani-motored Deperdussin, which was expected to casually cross the Pond most any day.

Another company at Hendon was the Handley-Page. They had one shed and were experimenting with a monoplane, with indifferent success. The future could not then be foretold, but I was certainly very pleased when Mr. Handley-Page made good on his bombing machines, for he persisted through many years of bad luck.

Gustav Hamel was another generally to be seen performing what then appeared to be the most astounding aerobatics. He generally flew a Bleriot monoplane with a Gnome engine, but later took to a Morane-Saulnier monoplane with a Le Rhone engine. Beatty was also frequently in evidence on an odd twin-propeller Wright machine.

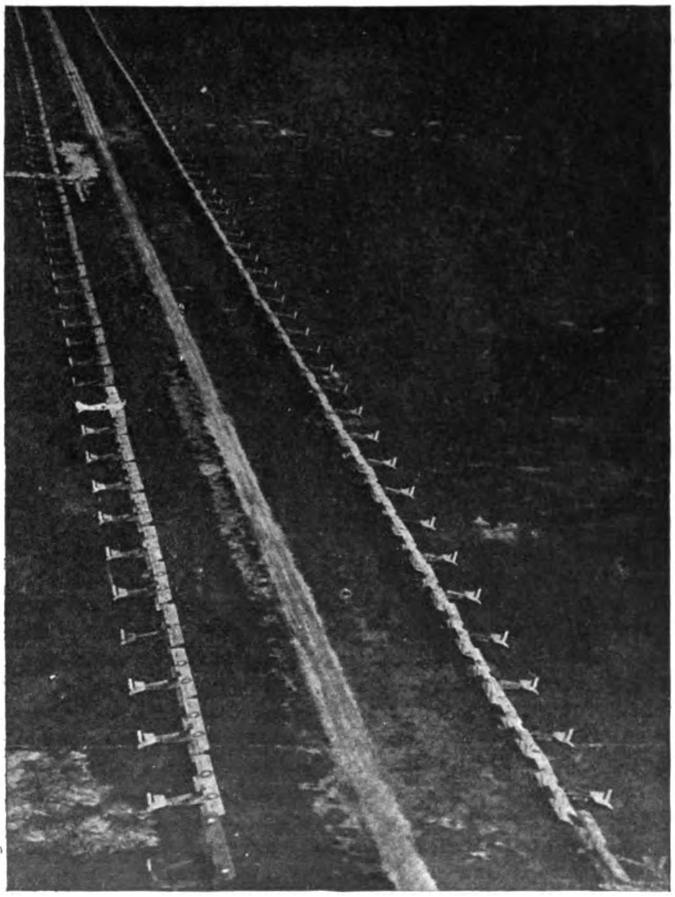


Photo by Int'l.

View of the flying field and its equipment of over 100 airplanes at Ellington Field, Houston, Texas. Contrasted with the flying fields described by Capt. Adams, some impression is gained of the rapid development of the airplane in the last five years

When I arrived at the Central Flying School, I was given a Short biplane with a 70 h.p. Gnome engine. It was one of the old box-kite types in which pilot and passenger sat side by side. The ailerons were of the non-balanced type; that is, owing to the absence of a balancing wire they hung straight down when the machine was stationary. The speed of the machine was somewhere about 40 miles an hour. I took my ticket on this machine about a week after I arived at the C. F. S.

The school was organized into 4 flights, A, B, C and D, and the pupils, who were both naval and military officers, were divided up amongst them. About half way through the three months course, the pupils were changed to other flights, so that on graduation each officer had flown at least two types of machine, generally one tractor and one pusher. A flight was equipped with Avros; B, with Maurice Farmans; C, with B.E. 2's; and D, with Henri Farmans and Shorts. In addition to actual flying the course entailed searching examinations on theory of flight, construction, rigging, engines, theoretical and practical meteorology, formation of troops, cross-country navigation, use of maps, and types of British and foreign war vessels.

Much of the engine instruction was devoted to the Gnome, which was the original rotary engine. It had seven cylinders. The exhaust valves were in the cylinder heads and opened direct into the air and the inlet valves were in the piston heads, the gas coming in through the crank case. There were, therefore, neither intake nor exhaust pipes.

I took my civilian pilot's certificate in May, 1913, and graduated at the Central Flying School as a military pilot in August. From then I joined No. 5 Squadron, R. F. C., at Farnborough.

The establishment of the military wing of the R. F. C. in those days was one squadron of airships and seven squadrons of airplanes. The whole was commanded by Lt. Col. F. H. Sykes. Each squadron of airplanes consisted of three flights. Each flight consisted of one Flight Commander, ranking as a Captain, and three flying officers ranking as Lieutenants or Second Lieutenants, and was equipped with 4 machines. The total officer personnel of a squadron was, 1 Major in command, 3 Captains and 15 Lieutenants or Second Lieutenants, six of whom acted as observers. All officers had to be pilots; equipment officers had not then come into being. The technical and routine work which nowadays is done by equipment officers was then carried out by the pilots themselves. The larger units such as wings, brigades and divisions were non-existent.

This establishment was only partially completed when I joined the corps, in fact there were only four airplane squadrons in existence and they were not completely equipped. The whole corps at that time was naturally in a very embryonic stage. My squadron had in it no fewer than seven different types of machines. These were:

The Maurice Farman "Longhorn," with 70 h.p. Renault V-type engine.

The Henri Farman with 80 h.p. Gnome engine. (These were both of the pusher type, the main difference being that the M. F. had a front elevator, whereas the H. F. had not.)

The single seater Avro, with 50 h.p. Gnome engine.

The Sopwith, with 80 h.p. Gnome engine.

The Caudron, with 45 h.p. Anzani engine.

The B.E. 2a, with 70 h.p. Renault engine.

The Graham-White, with 45 h.p. Anzani engine.

This last named machine was a quaint looking device and was popularly known as the "Pterodactyl." The fuselage projected some distance in front of the main planes and it was there that the observer sat with the engine immediately in front of him.

My flight was equipped with Avros. They were sporting machines to fly as they had, virtually speaking, no lateral control at all. The wings were supposed to warp, but as the warping cables were led up from the base of the first struts to the top of the second pair, very little bending of the wing tip could be obtained. In fact it had absolutely no effect at all! All lateral control had to be done with the rudder.

The B.E. 2 was another wing-warping machine, but in this case the warping cables were led straight from the fuselage to the top of the outer rear struts. This gave it twice the warping effect of the Avro. It was a very uncomfortable machine to fly on a rough day, as the wings were very flexible and frequently a gust under one wing would cause the wing to warp suddenly, which, acting through the control cables, would in many cases jerk the joystick out of the pilot's hands and give him a sharp blow on the inside of his knees. This machine was the forerunner of the numerous B.E. types.

Photo: Central News

The ease with which wireless communication is held with aircraft records some rapid progress since the writer of this article began to apply wireless to the airplanes of the British Royal Flying Corps

Photo: Int'l

The world's fastest airplane, built by Curtiss. Carrying a full military load it attained a speed of 160 miles per hour and climbed 13,000 feet in ten minutes. The 'bus in which the author learned to fly five years ago had less than one-fifth its power and one-quarter its speed. The triplane illustrated has a new 400 horsepower K-12 engine, which is lighter by 25 per cent than any other aeronautical engine

The corps at that time only consisted of about 60 officers, of whom 90 per cent were regulars, seconded or loaned to the R. F. C. from their respective regiments. It was a great life in those days, flying machines which viewed from the present day standpoint appear absolutely prehistoric.

I spent about four pleasant months doing practically nothing but flying. Then I began to feel that I wanted to progress. So I obtained leave and went up to London University and, metaphorically taking my coat off, got down to real hard work on theory and practice of wireless telegraphy with a view to applying it to aviation.

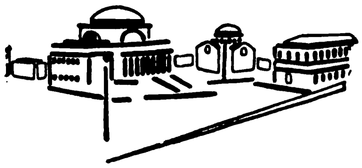
On the termination of this period of leave I returned to my squadron, and within a week an experimental flight was started consisting of eight officers. Great assistance was given by the Royal Engineers at Aldershot; they loaned the observatory and wireless station to the corps for experimental purposes. The particular job that I was detailed to was the theory and design of wireless installation on airplanes. The first installation was a Rouzet set, and it was upon this crude equipment as a start that the present day airplane wireless was built.

It would give great amusement to pilots of today could they see those old B.E.2 machines which we used for wireless experimental work. The fabric in many cases had to be removed from the wings in order that yards of wiring might be run round the edges of the planes to supply additional capacity.

As a start, the only thing attempted was to transmit messages from the machine at a low altitude to a station on the ground, but before the war broke out two machines had actually got into communication with each other in the air at a distance apart of about ten miles. In addition to myself, there were three other officers engaged on wireless work. All three are dead now, two were killed in the air, and the other died from illness. These three officers did all the practical flying work while I was mainly concerned with the solution of any mathematical problems which they presented to me, such as calculating the curve which a trailing wire aerial would take up at a given speed in order to see if it would clear the undercarriage while being unreeled, and similar problems. The trailing wire was the only type of aerial used, though suggestions were frequently forthcoming for draping aerials between the wing struts regardless of the additional wind resistance which they would cause.

(To be continued)

Progress In Radio Science



The Production of Tone Frequencies

METHODS of operating a wireless system over a wide range of tone frequencies devised by Oscar Roos are shown in the diagrams, figures 1 to 6.

The fundamental circuit is shown in figure 1. A condenser C-2 is connected in series with an inductance L-2 and a radio frequency alternator A-2, for which may be substituted, if desired, an arc generator of the Poulsen type. A spark gap S is included in the circuit, which may be placed in the field of a magnet M or in a vessel containing a compressed gas. Two trigger valves or arresters V and V-1 are connected on either side of the spark gap. These arresters may be an ordinary spark gap, a quenched spark gap, or two oppositely arranged rectifiers such as a point and plate rectifier, a hot and cold electrode rectifier, a mercury vapor rectifier or an aluminum or other film arrester. These arresters normally prevent the condenser C from discharging across the spark gap, but they are rendered ineffective through being broken down momentarily by an impulse from an auxiliary source, which in this case consists of two low voltage alternating current generators A and A-1 of different frequencies. Generator A is connected in series with inductance L and condenser C and generator A′ in series with inductance L′ and condenser C-1.

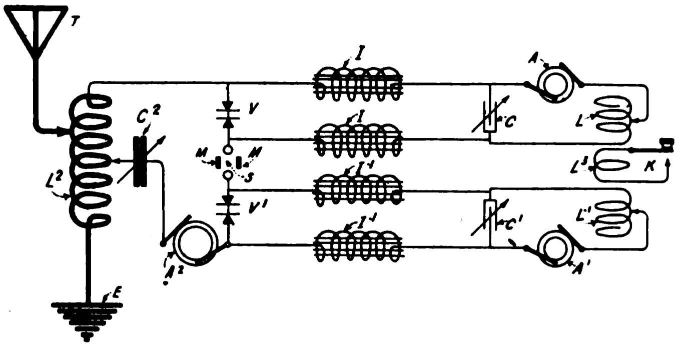


Figure 1—The fundamental circuit of the Roos wireless system for wide range of tone frequencies

Coils L and L-1 are placed in inductive relation by means of the linking system L-3 which includes the key K. By closing key K the circuits L, C and L-1, C-1 are thrown into resonance and the potential resulting therefrom breaks down the arresters V and V-1, thereby rendering the spark gap operative. If the frequency of the alternators A and A-1 are within the range of audio tones, the amplitude of the antenna oscillations will vary periodically accordingly.

A modification is shown in figures 2 and 3 where the condenser is charged by a direct current generator G, which is protected by the choke coils I and I-1. It is connected in series with the quenched spark gap S′.

In operation neither the high frequency generators A-1 or A-2 or the dynamo G can break down a larger gap than S-1 and S-2 and the arresters, therefore, prevent the discharge of the condenser C-2 across the gap unless they are simultaneously broken down. If n represents the frequency of generator and m the frequency of generator A-1, the arresters will be simultaneously broken down 2 (n—m) times per second and the tone produced in the receiving system will be the beat frequency of the generators. It is obvious that this tone may be varied over a great range by slightly altering the speed of one or both of the generators. The design of the dynamo G is such that it will have a falling voltage characteristic in order to prevent arcing in the spark gap. Figure 3 differs from 2 in that rectifiers are employed as arresters in place of the quench gaps S-2 shown in figure 2.

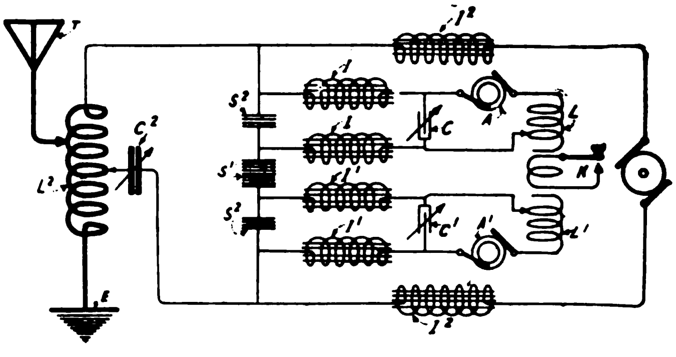


Figure 2—Modified circuit with a direct current generator, protected by choke coils, charging the condenser

The modified circuit in figure 4 has the auxiliary source of energy for discharging the main circuit, coupled to two alternators A and A-1 connected in series. By means of the valve connection V-2 both halves of the wave are rectified. By means of the transformers M and M-1 the energy of the resulting unidirectional impulses is impressed as two alternating currents having twice the frequency of the generators, respectively upon the circuit which includes the condenser C and the direct turn generator G. The generator normally cannot break down a larger gap than S, S-1 and the arresters therefore prevent the discharge

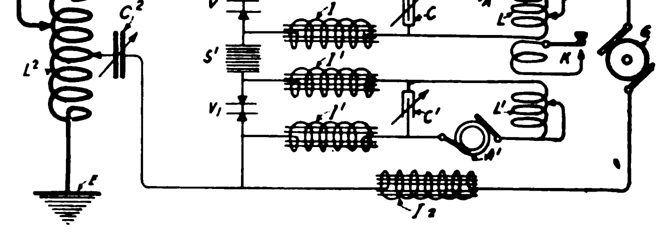


Figure 3—Showing circuit with rectifiers employed as arresters in place of quenched spark gaps

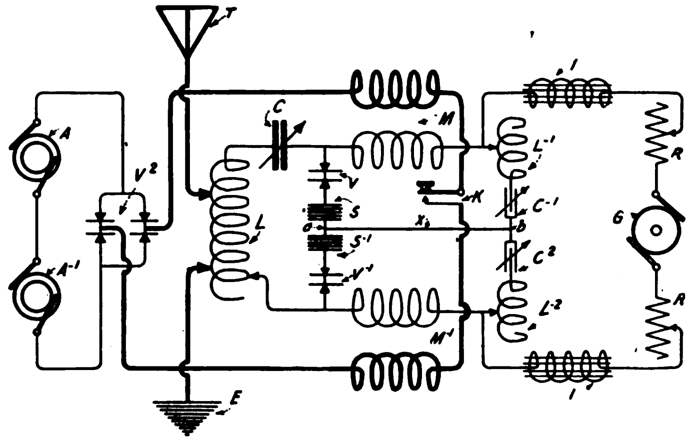


Figure 4—Diagram of connections, showing the auxiliary source of energy for discharging the main circuit, coupled to two alternators connected in series

of condenser C unless they are broken down simultaneously. They will be broken down simultaneously 4 (n—m) times per second where n and m represent the frequencies of the generators A and A-1. The tone produced in the receiving system will be the beat frequency of the alternating current developed, as mentioned before, in the secondaries of the transformers M and M-1 and this tone may be widely varied by slightly altering the speed of one or both of the generators.

The advantage of connecting the generators in series is, that the maximum beat voltage which is always the sum of the voltages of the two machines is much higher for a given beat frequency than that which other things being equal would be obtained from a single machine developing currents of the given frequency.

For example, if the normal or full-speed frequency of the generators is 8,000, then by reducing the speed of one of them so that its frequency is 4,000, the beat frequency will be 4,000 and the total voltage will be the sum of the full-speed voltage of one machine plus the half-speed voltage of the other, or 300% higher than the voltage of either machine running alone at 4,000 cycles. If, however, the beat frequency is much lower the advantage of the serial connection of the generators is more striking. For example, if the frequency of one machine is 8,000 and that of the other 7,500, the beat frequency will be 500, which corresponds to 1/16 full speed, while the total voltage is 31/32 the full voltage of both machines. Either machine running alone at 500 cycles would generate only 1/16 its normal or full speed voltage of 1/31, the voltage obtained by the Roos arrangement.

The generator G is protected from the currents of alternating current generators A and A-1 by a shunt having negligible reactance for the beat frequency. This is connected across the terminals of the generator as in figure 4.

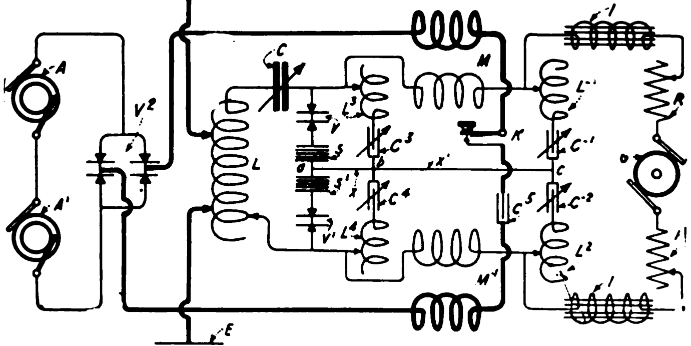


Figure 5—Circuit to augment the effect of the auxiliary source by sharper resonance

The shunt consists of a circuit L-1, C-1, B-2, L-2 which is tuned to the beat frequency of the alternating currents developed in the secondaries of the transformers M, M-1. This circuit consists of two serially connected branches, one branch C-2, L-2 being tuned to a frequency higher than the beat frequency and the other branch C-1, L-1 to a frequency lower than the beat frequency. The complete circuit L-1, C-1, C-2, L-2 being tuned to the beat frequency, it follows that this circuit has negligible reactance for currents of that frequency, and that the potential drop across the terminal of the circuit is practically nothing. Choke coils I, may be employed to protect the generator G from the effects of the oscillations developed by the discharge of the condenser C across the spark gap.

Because one branch L-2, C-2 is tuned to a frequency higher than the beat frequency and has capacity reactance, and the other branch L-1, C-1 is tuned to a frequency lower than the beat frequency and has inductance reactance, the passage of the beat frequency current through the circuit L-1, C-1, C-2, L-2, L, C, will develop a high potential difference between the terminals of the arresters V, V-1 respectively. They break down simultaneously and permit the condenser C to discharge across the gaps S, S-1.

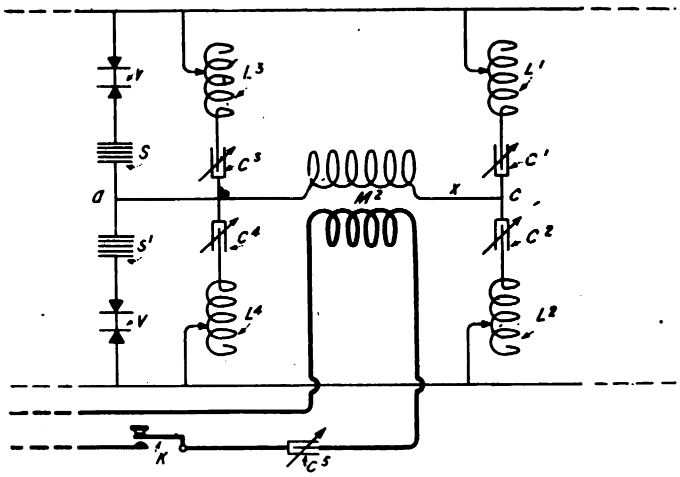


Figure 6—Detail of figure 5 indicating the association of the auxiliary source circuits with the transformer without change in mode of operation

It will thus be seen that the system shown in figure 4 meets the contradictory requirements of low beat frequency voltage across the choke coils I, I, for the protection of the generator G and high beat frequency voltage across the arresters for momentarily breaking them down and rendering them ineffective.

To augment the effect of the auxiliary source by sharper resonance the high impedance of the radio frequency circuit C, L is eliminated for currents of beat frequencies by using the arrangement shown in figures 5 and 6, in which a second circuit L-3, C-3, C-4, L-4 tuned to the beat frequency, is connected across the system. This circuit consists of the branch L-3, C-3 tuned to a frequency higher than the beat frequency and the branch C-4, L-4 tuned to a frequency lower than the beat frequency.

The branches L-3, C-3 and C-2, L-2 are both tuned to the same frequency and branches L-4, C-4 and C-1, L-1 are both tuned to the same but lower frequency, so that the circuits L-4, C-4, X-1, C-2, L-2 and L-3, C-3, X-1, C-1, L-1 are each tuned to the beat frequency. The secondaries of the transformers M, M-1 are so connected that the beat frequency currents will flow in the last named circuits and have a common direction in the conductor X-1, thereby avoiding the radio frequency circuit C, L which has a high impedance for this current. These currents are amplified by resonance.

As indicated in figure 6, the circuit of the auxiliary source may be associated with the transformer M-2 or otherwise with the branch X-1 without changing the mode of operation. A transmitting key may be connected in the circuit of the auxiliary source or otherwise associated with the system.

Rouzet Transmitting System for Increasing Spark Frequencies

A SYSTEM of obtaining high spark discharge frequencies from oscillation circuits excited by a three phase low frequency generator, has been devised by Lucien Rouzet of Paris. M. Rouzet mentions one of the advantages of employing multi-phase current is that the generator is kept on load during transmission and the output is therefore more steady than in a single phase system. An objection to the use of a single phase high frequency generator is that it requires a low self induction which increases the problem of design. Furthermore in high frequency systems the time of the charging period is reduced as the frequency is increased, but the discharge period, whether for low or high frequencies, remains the same. On the other hand in systems employing charging currents of low frequency the period of discharge is short compared with the period of charging which increases the efficiency considerably, principally because it reduces the short circuit current which generally occurs while the condenser is discharging across the spark gap.

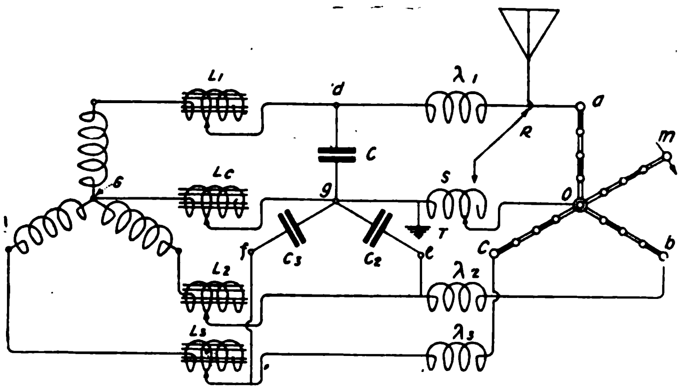
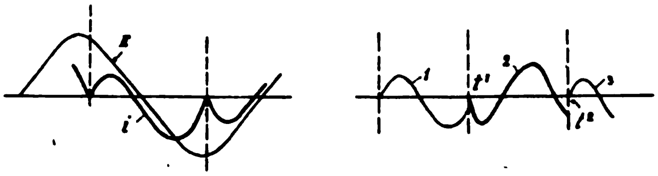


Figure 1—Fundamental wiring diagram of the Rouzet transmitting system for increasing spark frequencies

To show the increase in amplitude of the radio frequency currents generated by the Rouzet system, as compared with the single phase high frequency system, the curves of figures 2, 3 and 4 are shown. Figures 2 and 3 indicate the relative amplitude to be expected from a single phase system, in which the spark discharges synchronously, that is, twice per cycle. Figure 4 indicates the amplitude in the three phases of a three phase system as well as in the neutral wire.

The fundamental wiring diagram in figure 1 shows a star-connected three phase source of current G, which may be a multi-phase alternator or the secondary winding of a high potential three phase transformer. As will be seen each phase feeds a condenser, the three condensers C-1, C-2, and C-3, being star connected. Their neutral point G is connected to the neutral wire. The charging circuit is further made resonant by means of the inductances L-1, L-2, L-3, and L-c.

The rotary spark gap contains three sets of stationary electrodes, A, B, and C, and a rotating member, M, which is so designed that when OM is in the position OA, OB or OC, four spark discharges in series take place and the condensers are discharged successively in resonance with the charging current.



Figures 2 and 3—Graphic curve showing the relative amplitude to be expected from a single phase system

If the rotating arm of the spark gap revolves at a rate of two revolutions for each charging period, two discharges per period will be obtained in each phase, giving a total of 6 discharges per revolution. In order to maintain identical periods of oscillation in each discharge circuit, inductances are inserted in each branch.

In summary, each condenser with its particular phase acts as a single phase system, but the total number of discharges will be three times that of a single phase system or, in other words, the spark frequency is increased. By proper adjustment of the rotary spark gap, the spark can be made to take place when the charging current passes through a zero value, thereby preventing arcing; but this can only be accomplished when the charging circuit is properly tuned itself.

Figure 4 shows the super-position of the curves i_1, i_2 and i_3 of the stages of a three phase star-connected system. The sum of the currents passing through the neutral wire is represented by the curve I_c. In such a system this curve is of the regular shape and the current varies with a frequency equal to the threefold frequency of the phase voltage.

The antenna oscillation transformer is included between the points G and O and in this case is of the conductively coupled type. Inductive coupling, may, however, be employed.

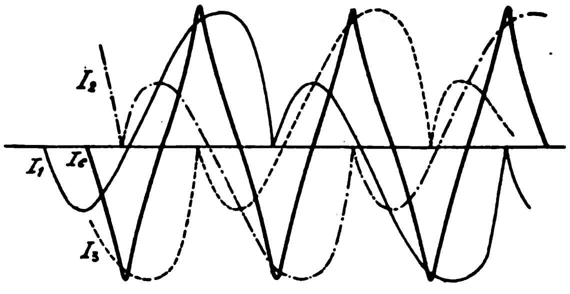


Figure 4—Graphic chart indicating the amplitude in the three phases of a three phase system

Magnetic Modulating System for Wireless Telephony

IN wireless telephony, if the carrier or high frequency currents are modulated by varying the permeability of a radio frequency transformer with an iron core, the speech signals are distorted by hysteresis in the iron. There has been devised by Ralph V. L. Hartley, of New York, a modulating system of the type mentioned, wherein the hysteresis effects are considerably reduced and the quality of the speech signals improved accordingly. It has been found also that a reduction of hysteresis improves the sensitiveness of the modulator. The factor of sensitiveness is defined by Mr. Hartley as the ratio of the modulated high frequency power to the low frequency power affecting the modulation.

One way in which the desired modulation is effected by this invention is by subjecting the magnetic core to a relatively weak and rapidly alternating cross magnetization, which keeps the molecules of the iron in a constant state of agitation and renders them more susceptible to changes in the longitudinal magnetization produced by the currents of speech frequency. Figure 1 illustrates the preferred form of design in which the winding for the reduction of hysteresis is placed at right angles to the signaling and carrier frequency windings. Figure 2 illustrates a modification in which the carrier current windings are at right angles to the remaining winding. Figure 3 shows the details of the magnetic core construction.

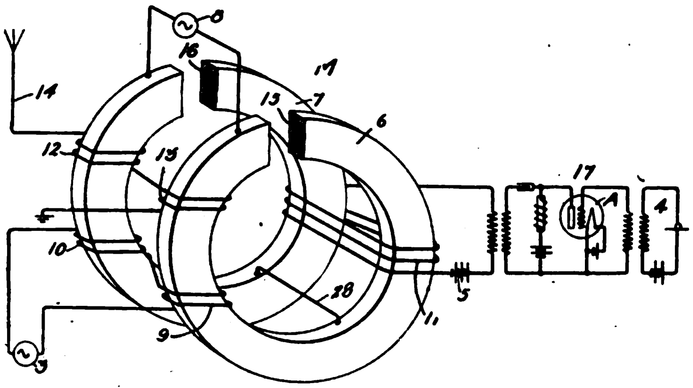


Figure 1—Design of apparatus for the magnetic modulating system of wireless telephony

In figure 1 the modulator M, which is of the magnetic type, is supplied with radio frequency currents from the source 3, which are to be modulated by speech currents supplied by the signaling circuit 4. The battery 5 supplies a steady current which brings the magnetization of the toroidal cores 6 and 7 to the desired point about which the magnetization is varied by the signaling currents. The source 8 supplies currents of a frequency higher than the carrier frequency supplied by the source 3 for the purpose of reducing the hysteresis. The circuit of source 8 may be traced from the source through the turns of coil 16 in series to conductor 28, through the turns of coil 15 in series, back to source 8.

The carrier source 3 supplies currents to the primary windings 9 and 10, which are individual to each of the cores 6 and 7, and which produce high frequency fluxes in opposite directions in these cores so that the signaling winding 11, which is common to both cores, is substantially non-inductively related to the windings 9 and 10. The opposing high frequency fluxes induce a resultant zero carrier frequency electromotive force in the signaling winding 11. The secondary windings 12 and 13 are adapted to supply speech modulated carrier currents to the radiating antenna system 14. The windings 12 and 13 are wound in opposite directions and are individual to each of the cores 6 and 7.

In order to reduce the hysteresis in the magnetic cores 6 and 7, windings 15 and 16, disposed within the cores 6 and 7, are provided for producing a magnetic field which is at right angles to the magnetic field produced by signaling winding 11 and the windings 9, 10, 13 and 12. The windings 15 and 16 are supplied by the source 8 with comparatively weak and very rapidly alternating currents, which have a frequency which is higher than that supplied by the carrier source 3. The signaling current supplied by the circuit 4 may be amplified, if desired, by one or more amplifiers 17 of the vacuum tube type.

The cores 6 and 7 may be constructed as shown in figure 3, in which the halves of the cores 18 and 19, which are held in assembled position, are made of compressed iron dust, and are channeled to receive the winding.

In figure 2 the antenna circuit may be traced from antenna 14 through the turns of the secondary winding 22 in series to ground at 29. The carrier current sources 3 is connected in series with primary winding 21. Windings 21 and 22 are both disposed within magnetic core 23. The low frequency winding 24 is wound around the core 23 so that the high frequency carrier current windings 21 and 22 produce magnetic fields which are at right angles to that produced by the signaling winding 24. The signaling winding 24 is non-inductively related to the carrier frequency windings 21 and 22, and the signaling winding 24 will accordingly not have any carrier frequency currents induced therein. This relative disposition of the carrier frequency winding and the signaling winding reduces the distortion, as the molecules of the core are agitated by the magnetic field due to the carrier currents and are more readily susceptible to changes in the field due to the signaling current. To reduce the hysteresis loss due to the carrier frequency alternating field in the core 23, the source 8, supplying a frequency higher than the carrier frequency, in this case is connected through condensers 25 and 26 about a portion 27 of the signaling winding 24. The rapidly alternating magnetic field produced by the currents traversing the portion 27 of the winding 24 produces a field which is at right angles to the carrier frequency field so that the hysteresis is reduced, as in figure 1, by the high frequency cross-magnetizing field.

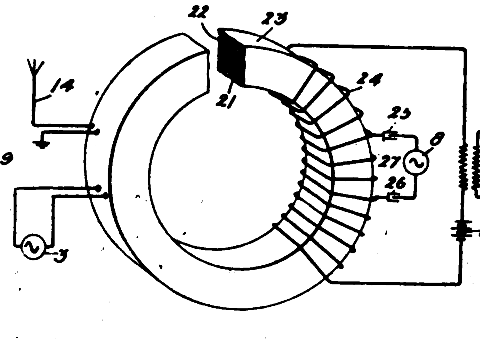


Figure 2—A modification showing the carrier current windings at right angles to remaining windings

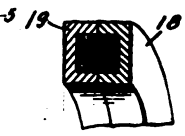


Figure 3 — Showing detail construction of the magnetic core

Feature Articles for the March Wireless Age

The Weagant Three-electrode Vacuum Tube and Its Application in Commercial Radio.

Multiplex Wire Telephony by Radio Frequency Currents.

Winding Up the War

Photo Press Ill. Service.

That matters in Russia are still unsettled is recalled by this glimpse of a frowning Japanese gun, above, in a test of fire control by wireless phone

The airplane shown at the left dropped a floral wreath as it flew over the Roosevelt home, a tribute to the dead ex-President who lost an aviator son in France

Photo by Int'l.

A remarkable picture of the President reviewing troops at the front. Watching the victorious Yankee boys go by are Generals Pershing, Liggett and Bullard. Mrs. Wilson is seated behind the President

Photo by Int'l.

The Monthly Service Bulletin of the NATIONAL WIRELESS ASSOCIATION

Founded to promote the best interests of radio communication among wireless amateurs in America

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A Plan for Organization

BEFORE the war there was a duplication of effort in amateur clubs and associations. With the re-opening day well in sight now, it appears that a discussion of better organization of the amateur field is a timely subject.

Organization of amateur interests by States seems the logical solution. State organizations have existed in the past, but in many cases the ends achieved were futile and the percentage of failure high. These failures were generally due to one or more of the following reasons:

1. Lack of funds
2. Insufficient power to control work of members
3. Jealousy between organizations
4. Rivalry between officers and directors
5. Insufficient co-relation between local clubs
6. Not close enough co-operation with State and National organization.

Platforms have not been broad enough. Either promotion of relaying or research work has been the dominating objective. These should be co-related and fostered simultaneously by a central agency.

Spasmodic bulletins and occasional circular letters have generally been the only means for directors to keep in touch with members. This method is inadequate.

The eventual solution should rest in a line-up something like this: Local clubs should maintain close co-operative relations with a State organization, as the basic unit to establish affiliation with a national body.

A member of each State unit should be elected to a national council to represent it in planning for the best interests of the amateur in questions of an inter-state nature.

State organizations should be controlled by a board of directors comprising five elected officers. The term of office should be one year, with re-election by general vote. The offices to be filled may be suggested as follows: President, Vice President, Secretary-Treasurer, Corresponding Secretary, Publicity Director. An important function of the Board's activities would be establishing close co-operation with Committee chairmen.

The following committees should be sufficient to cover all needs in the majority of States:

Membership
Affiliation
Research and Development
Interference
Relay
Publicity
Meetings and Conventions

The function of most of these committees is evident from their names, but a few may need explanation. The affiliation committee's purpose would be rendering assistance to local clubs in their general activities, such as providing interesting papers and programs for their meetings (to take the place of the usual unprofitable disputes as to who does the most jamming), to give advice on financial problems and difficulties would be a necessary part of this committee's work, the members of which should become informed in the best methods of securing funds and stimulating club members' interest so they continue payment of dues.

The principal function of the interference committee would be to devise regulations for working in congested districts, arrange equitable divisions of time for operation where required, and to secure the earnest co-operation of federal officials through consistent effort to minimize or eliminate the evil of unnecessary interference. Adjustment of apparatus where the owners of stations are not willing or capable, might well become an important part of the field work of this committee. The effectiveness of this committee would, in large measure, be dependent upon the authority it would secure by loyal backing from the members. If a sufficient number would abide by the

(*Continued on Page* 35.)

DEPARTMENT OF COMMERCE
BUREAU OF NAVIGATION
WASHINGTON

December 20, 1918.

The Radio Laws and Regulations of the United States, edition July 27, 1914, are amended in the following respect:

Par. 122, page 63, amended this date, to read:

Amateur first grade: The applicant must have a sufficient knowledge of the adjustment and operation of the apparatus which he wishes to operate and of the regulations of the international convention and acts of Congress in so far as they relate to interference with other radio communication and impose certain duties on all grades of operators. The applicant must be able to transmit and receive Continental Morse at a speed sufficient to enable him to recognize distress calls or the official "keep-out" signals. A speed of at least ten words per minute (five letters to the word) must be attained.

Par. 126, page 64, amended this date, to read:

The code test shall continue for five minutes at a speed of 20 words, 12 words, and 10 words per minute, respectively, for the commercial first, second, and amateur first grade, 5 letters, numerals, or other characters to the word, and to qualify the applicant must receive 20, 12 and 10 words in consecutive order accurately and legibly written. Operators will not be permitted to break or interrupt while receiving or to correct or alter the transcription after it has been submitted to the examining officer.

You will note from the above amendments that it is the purpose of the Department to require future applicants for amateur first grade radio operator's license to qualify in the transmission and reception of Continental Morse code at the rate of ten words per minute instead of five as heretofore.

Respectfully,
E. T. Chamberlain,
Commissioner.

The Attack on the Alexander Bill

How the Proposed Legislation to Wipe Out Amateur Wireless Was Fought Before the Congressional Committee and the Demand for Prior Rights Recognized

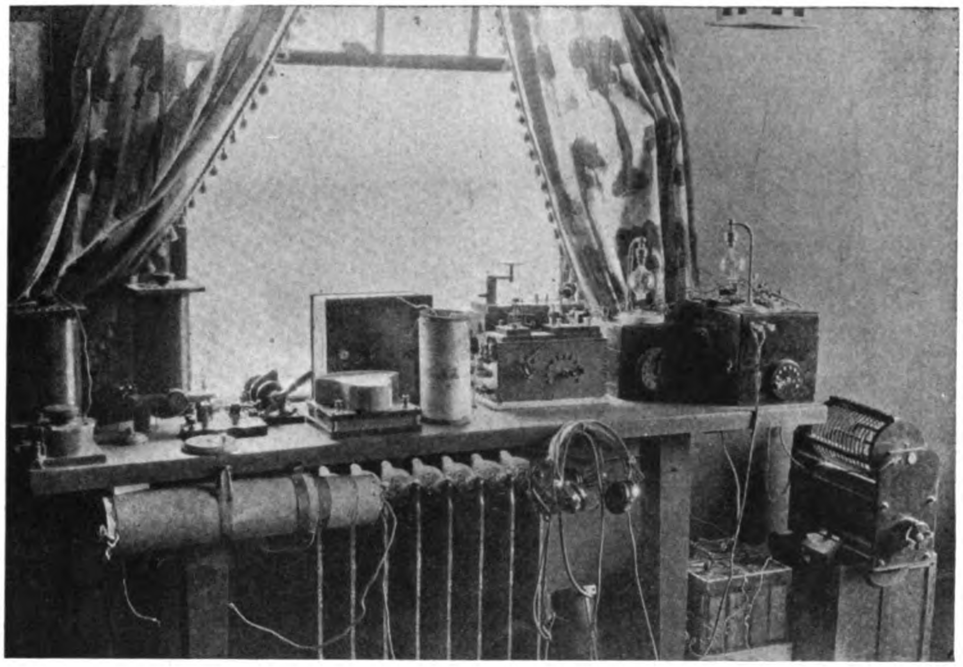
Reported by J. Andrew White

TO relieve the tension and satisfy the natural yearning for details aroused by the Washington dispatch, headed "Victory! Get Ready for Re-Opening of Stations," which appeared in the January issue, the account which follows has been prepared so all members may know what transpired in Washington in the matter of defeating the project for government ownership of wireless.

But—first of all—the amateurs of the United States are open to congratulation for the sane way in which their protests against the Alexander Bill were presented. N. W. A. Headquarters worked overtime replying to letters from members, prior to the opening of the Congressional Committee hearings; all inquirers were told that the matter was in the hands of a Special Committee of the Association and vigorous steps would be taken to kill the proposed legislation. And from what the N. W. A. representatives learned in Washington, the course prescribed was pursued to the letter. This time the "my-son-Johnny-is-being-deprived" type of letter did not appear; the written protests which the Congressmen received were dignified and awakened admiration for the high type of experimenter the field represents. The lesson from previous mistakes was well learned; when the amateur's case was presented this time it had lost the aspect of the youth in short trousers playing with a toy. Congress, from now on, will take amateur wireless seriously.

But, to tell the story: When the association's special Committee arrived in Washington the foundation had been well laid. All amateur interest had worked together in full harmony and so diligently that every member of the Congressional Committee had before him many well-written and pithy protests from all over the nation. Copies of the "Protests with a Point" articles, by the Acting President, the Technical Committee and Vice-Presidents Kennelly and Goldsmith—which were printed in full in the January issue—were placed in all the Congressmen's hands, along with the co-operative pleas of Mr. Maxim, Mr. Pacent, Mr. Rawson, Mr. Grebe and Mr. Grinan. From the beginning, the outlook was very favorable.

On the day before the hearings opened the Navy evidently considered the bill would fail because of the formidable amateur opposition. The officers of the American Radio Relay League were invited to meet in conference with the Naval Radio Officials to effect a compromise in the form of an amendment. The substance of this amendment—which appears a little further on in this article—was agreed upon, it being understood that a neutral position be then taken on the government ownership proposition. The amendment was introduced by the Navy on the very first day of the hearing. That evening an assemblage of leading and representative amateurs met at a dinner in the New Ebbitt Hotel. A difference of opinion developed in the matter of giving the Navy a monopoly, and in accepting the amendment. Twenty or more men, all representative amateurs, discussed these questions to a conclusion which showed the majority opposed, as individuals, to government control, and a desire to continue under the old law.



A wireless club's former receiving apparatus with a daylight range of 1400 miles; night range, 2,800 miles

Naval officials were told about this meeting on the following morning, the second day of the hearing, and advised of the belief that the bill and amendment would fail. **It was then admitted that the N. W. A. officials had been purposely left out of the conference because the attitude of the Association was known; that its officers would not accept any amendment on behalf of the amateurs and that it would actively oppose the proposal for a Naval monopoly, continuing its fight for the resumption of amateur wireless in peace times under the old law.**

That practically all the amateurs who later appeared before the Congressional Committee also took this attitude, without prior understanding, was gratifying to the officers of the Association, for it confirmed the belief upon which their stand was taken—the old law being satisfactory, no change was wanted, and no amendment of the Alexander Bill would be accepted as a compromise.

With complete victory now in sight, there is cause for mutual congratulation. Just how the discussion of amateur affairs was carried on in the hearings thus takes on renewed interest. The summary follows:

Secretary of the Navy Daniels appeared in behalf of the bill, which the Chairman stated was presented by the Navy Department in a large measure, in his belief. Mr. Daniels characterized the bill as one that would give the Navy Department the exclusive ownership of all wireless communication for commercial purposes.

One of the reasons for the proposal was that "the question of interference does not come in at all in the matter of cables and telegraphs, but only in wireless."

"We strongly believe," said the Secretary, "that having demonstrated in the war the excellent service and the necessity of unified ownership, we should not lose the advantage of it in peace." Because the naval organization fulfilled its purpose and won the commendation of not only our country, but of all countries during the war, Mr. Daniels reasoned that the service "is so well prepared to undertake this work and to carry it on that we would lose very much by dissipating it and opening the use of radio communication again to rival companies." The exact reason for the necessity of unified control under the Navy Department appears from Mr. Daniels' testimony to be great increases, present and prospective, in the number of vessels on our coasts and the consequent increase in radio communication on many different wave lengths.

Congressman Green of Massachusetts early in the hearing interrupted the Secretary of the Navy, with the opinion that his statement disclosed "government monopoly, contrary to any control that we hoped for years to establish under the Sherman anti-trust law. This becomes an immense trust, and it also becomes, according to my view of it, the establishment of the Department of the Navy in commercial business." He emphasized his indignation by continuing, "there are a number of gentlemen here who have had some experience in radio communication. I never heard before that it was necessary for one person to own all the air in order to breathe; and I believe that radio business has been and can be carried on without government monopoly. We all admit that during the war it was a very proper thing to have absolute control, but now in times of piping peace, it seems to me that there is a great opportunity to obtain advancement in the radio service even outside of the Navy Department. I do not think that all the wisdom is contained there; it has not been heretofore, and I do not think that it is all contained there now." Mr. Green was unwilling to consider that the Navy personnel was entitled to full credit for what had been accomplished. He stated that in time of war it was right that the Navy Department should have everything it needed, and that they have had it, and also all the advantage of the number of men who enlisted in the Navy for the purpose of extending the radio service. "I know of men in my own city," he remarked, "who were pronounced amateurs; yet they have some brains, and they have improved their brains and have improved their apparatus."

In the discussion of the imperialistic attitude of the Navy reflected in the bill, Congressman Saunders of Virginia, noted that it appeared that the average citizen would be inhibited from establishing a plant of his own. The Secretary of the Navy replied that the bill carried with it the authority to issue special licenses, which might be given wherever the public required it.

Mr. Saunders said he had not found such a provision in the bill, and Secretary Daniels read Section 5, as follows:—

> That the Secretary of the Navy may issue special licenses, subject to such conditions and restrictions and for such periods as he deems proper, for the establishment and operation of stations for special emergency use—

"Yes, for 'special emergency'," Mr. Saunders interrupted. "Now that does not contemplate a general commercial condition, of course. It says, 'in cases where no other rapid means of communication is available'; that makes it more unlikely, therefore, that the man will be able to get any special permit."

The Secretary replied that licenses could be given if they did not interfere with the naval stations, which caused Mr. Saunders to observe, that this action could hardly be called "special emergency use in cases where no other rapid means of communication are available."

During the discussion which followed, the Secretary of the Navy struck out the objectionable features of that paragraph of the bill.

Congressman Saunders asked for a definition of interference from a naval point of view, and received the reply that by this was meant interference with the operation of the general system. The Congressman then observed that this appeared to be a matter of regulation as to the wave lengths to be used; to which Secretary Daniels replied, "we ought to have it absolutely—except in special cases—governmental owned and governmental operated."

Mr. Saunders criticized this viewpoint, saying that if that policy was to be pursued it would be difficult for private enterprise to show such a case of emergency, in fact, under the bill and policy the Navy had in mind, there would be no such private enterprise. This drew the admission from Secretary Daniels, "Well, in the main, there would not be."

Commander Hooper of the Navy replied to the question of Congressman Beshlin, of Pennsylvania, as to whether indiscriminate use of the wireless by people throughout the country interfered with its use by the government, to the effect: Amateur stations could be regulated so that they would not interfere, and still satisfy the amateurs.

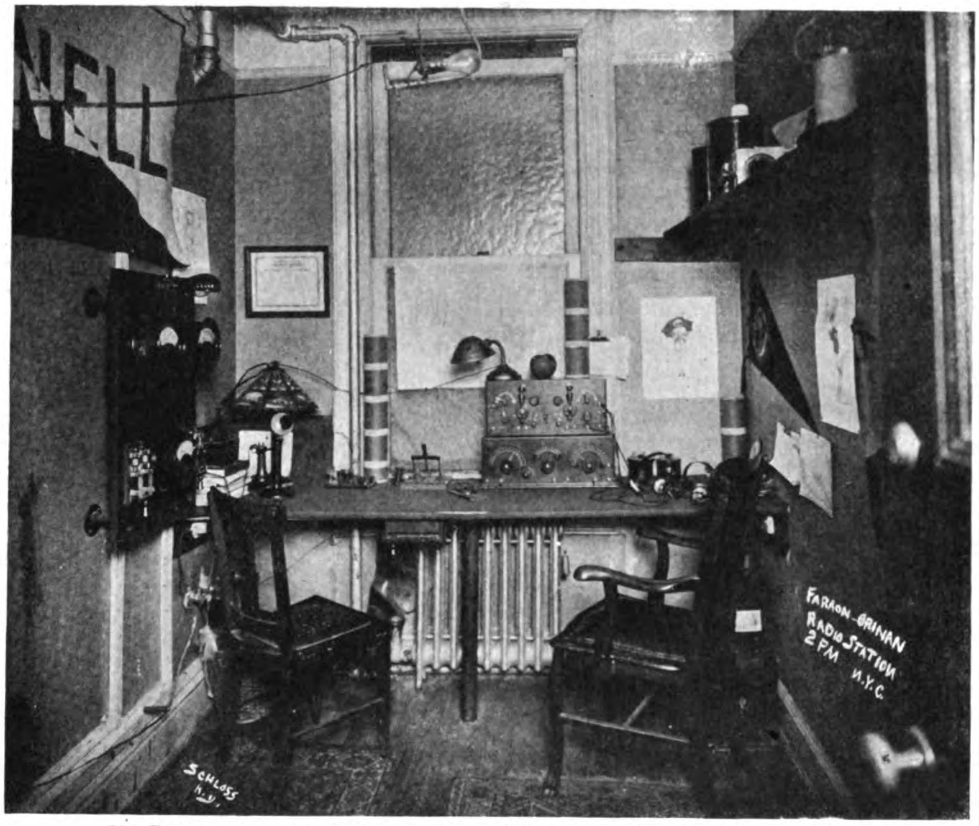
Before the close of the first morning's session, the Navy apparently realized the futility of attempting to legislate the amateur out of existence, for at the conclusion of his testimony Secretary Daniels announced that, following the noon recess, an amendment to the bill would be presented by Captain Todd, Director of Naval Communications.

This amendment proved to be one concerning the amateurs. Captain Todd said: "The part of the bill providing for experiment stations I had hoped would cover the question of amateurs. Apparently, from what I have heard, the amateur wishes to be mentioned as such. I had an idea that it would dignify the amateur to have his station considered under the head of experiment stations." The amendment was presented with the comment from Captain Todd that he had every reason to believe that the amateur interests would be thoroughly satisfied. In substance the amendment was as follows:

> The insertion of: "The term, 'amateur station,' means a station used for private practice or experiment in radio communication and not operated for profit in either receiving or sending radio signals."
>
> The addition of the term "amateur stations" after the provision for "training-school stations," thus including amateur stations specifically in the provisions of the law.
>
> Reframing the paragraph relating to licenses for amateur stations, licensed as private stations under the Act of Aug 13, 1912, "Provided, that when such amateur stations are licensed for receiving purposes only, no operator's license shall be required for the operator in charge of operating such

station; but when such amateur station is licensed for transmitting also, the license shall require that the operator of such station shall hold a license showing his ability to send and receive at least 75 letters per minute in the Continental Morse code: And further provided, That the license for such transmitting station may limit the power input to one-half kilowatt in case of amateur stations within one hundred miles of the Atlantic or Pacific Ocean, the Gulf of Mexico, or the Great Lakes, and to one-quarter kilowatt within five miles of a Government receiving station. Amateur stations so licensed shall not use any wave length exceeding two hundred and fifty meters, nor less than one hundred and fifty meters, except by special authority in the license contained."

Captain Todd stated that he hoped that this amendment was satisfactory to the amateurs.



The Faraon-Grinan record breaking relay radio station, a typical amateur plant

During the course of the testimony of the Director of Naval Communications, Congressman Edmonds of Pennsylvania, remarked to Captain Todd: "Of course, you realize that after this bill becomes effective there will be no radio schools, but simply experimental amateurs, and of course there will be no place for a man to get a position."

Congressman Green took exception to the lack of opportunity for the young men if radio was under government ownership. "Harking back to the early days before the days of telegraphy and other things," he said, "and before the days of travel by cars, the country started with very small beginnings and it has grown, and developed, and widened, and broadened, and beaten out all other nations, and now we come to tie everything up so tight that we have to be careful where we step. We have got to have our possibilities bound up by cords that we cannot break. We would be punished if we undertake to do anything. I am of the opinion that it is too much to ask the people of America to punish the people of America by restraining all their abilities and opportunities and all their hopes and expectations. You have to have some place of opportunity that young men can in the future get into, because they cannot get into the Navy because the Navy will not increase as it has during the war, and the Navy bottles up and keeps for itself the opportunities and keeps everybody out.

"I believe in the broadest chance to the American, and especially to the coming American," he continued, "and the coming American would be fully equal to the present, because the opportunities of education are far superior to what they were in my early days. I had no opportunity of education. I may have had the ability, but I did not have the opportunity to secure education, but had to go to work; and the youths that grow up today, even the young men born poor, have every opportunity, and I want them to have some inspiration. This bill ties up all the inspiration that every young man has."

The balance of Captain Todd's statement before the Committee was confined to the broad commercial questions in all wireless communication, other than those affecting the amateurs.

He was followed by Lieut. J. C. Cooper, Jr., who announced that he was an ex-amateur who had been in the Naval service during the period of the emergency. Lieut. Cooper disclosed the interesting fact that several days prior to the opening of the Congressional hearing a meeting was called in Capt. Todd's office of all the ex-amateurs who happened to be on duty in the Naval Service in Washington. About thirty responded. It was as the collective judgment of these men that the amendment to the bill was offered.

Lieut. Cooper paid a high tribute to the amateur as a useful member of the community. "I personally, as a Naval officer," he said, "have had many operators under me. I have found that of the new men under me the easiest trained, the most adaptable to the new apparatus, and the most efficient men I had, were ex-amateur operators." He added that two of his best men had been put on the President's ship to receive the official messages from Washington, and that they were both ex-amateur operators.

The amendment, he noted, licensed receiving stations without requiring a license of the operator. In other words, the beginner need not be a radio operator to operate a receiving station. "We do not think," he observed, "on the other hand, that any amateur should have the right to touch a key and to cause possible blundering interference by his lack of ability as an operator unless he can receive and send what is usually called 15 words a minute, that is, 75 letters per minute, in the ordinary standard of 5 letters to a word. If he is required to have that degree of skill it will be an incentive to him when he is first learning the art."

He noted in connection with the amendment submitted by the Navy, a clause limiting the transformer input of amateur stations to one-half kilowatt if within 100 miles of the seacoast or to one-quarter kilowatt if within 5 miles of a Government receiving station. He gave his personal opinion that the limits were as reasonable as could be safe from a point of view of non-interference with official and commercial dispatches. He noted also that a license could be issued up to one kilowatt under these limitations, the amendment stating that the Government may in its discretion put these limits on. The amendment left it in the discretion of the licensing power to cut down to those limitations amateur stations near the centers of commerce, and still allow the amateur to work.

Congressman Saunders asked Lieut. Cooper for an opinion on the original bill, whether he considered that there was any provision whatever in it regarding the amateurs. Lieut. Cooper replied that he understood that it was the intention of the Navy to license amateur wireless operators.

Mr. Saunders disagreed, stating that he did not see where an individual who had been working an isolated amateur station for intellectual improvement would be covered by the term "experimental station." In fact, the Congressman insisted, before any man could start out as an amateur he must have had the opportunity to take some training at some school. The Congressman questioned Lieut. Cooper as to whether he could see any danger of interference with commercial or government message traffic, to which Lieut. Cooper replied, that he thought interfence was eliminated, "with the exception of the fact that adequate inspection of amateur stations must be had in the future if the amateur is to maintain the dignified position that he should in the radio world."

The ex-amateur sounded a note of warning as follows: "There is one coming factor in radio work which may adversely affect amateur operating which should be looked forward to at the present time. The fleet is using for intercommunicating purposes very short wave lengths, shorter than the 150 meters mentioned as the minimum length that an amateur should use. Aircraft are also using various wave lengths, some of which are almost down to 250 meters. There may be trouble in the future between aircraft operating overland and working with their receiving or transmitting stations, and amateur stations. That is a possibility of the future. Aircraft radio was not in existence to any extent when amateurs last operated. There may be interference between amateur operators and aircraft radio stations, but it is hoped that there will not be."

Mr. Saunders then brought out the point that government ownership had nothing to do with that problem, and that it could be met by appropriate regulation.

Commander S. C. Hooper, Executive Officer, Radio Division, Bureau of Steam Engineering, Navy Department, was called. He prefaced his general statement with the following observation:

"I do not think that it will be out of the way if I should pay tribute to the fine co-operation and the fine work of the radio manufacturers and inventors and amateurs in our country. When war came on us we were totally unprepared to handle the entire situation. The amateurs saved the day when we had to man the entire merchant marine by naval operators in order to incorporate the merchant marine into the naval system.

"The manufacturers came down to Washington and placed themselves at our disposal, and in every way possible did their utmost to further the plans and slightest desires of the department. The inventors were keen and active in every effort in their research work to produce what might be used against our common enemy. I take particular pains to mention the assistance given by Mr. Nally, vice president and general manager of the Marconi Company, whose company more than anyone else suffered through what war brought upon them; and also of the Federal Telegraph Company, which stood next in being harmed, due to the Government closing the stations.

"These officers have performed a service as great as any military officer in the radio work for the Government in time of war, and this service should be recognized in some way. They know in their conscience that they have done a great good to the country, the same as the soldiers and sailors have done, and it ought to go down in the records of history that they have done their duty."

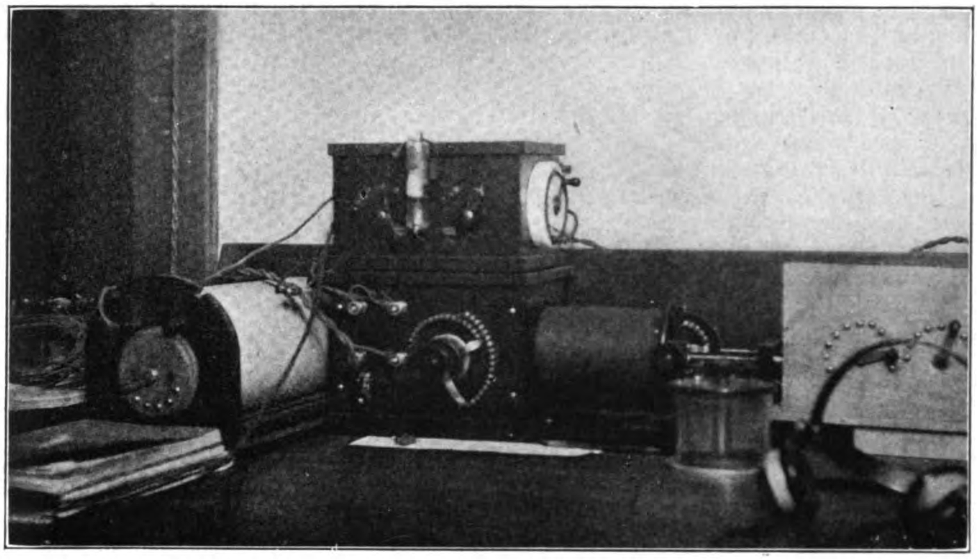
His testimony was mainly on the technical point of view in the subject of government ownership, dealing principally with the cause of interferences. In connection with the amateur problem he stated: "I agree it is very interesting to the amateur, and very educational, and it is a great advantage to the radio art to permit the amateurs to develop themselves, and it is of great value to the Government to have all these operators self-trained in case war comes upon us.

"The amateurs, of course, cannot afford to expend large sums of money on radio stations and build aerials for long wave lengths, and naturally they prefer to have the short wave lengths and small aerials, which fit admirably into our organization and are in accordance with the present law."

Edward J. Nally, vice president and general manager of the Marconi Wireless Telegraph Company of America, who appeared in opposition to the bill, observed in the course of his testimony that if the amendment represented the joint view of the Navy officials and that of the amateurs, the Marconi Company "was glad to add its voice in approval, and to express the opinion that the proposed regulation covering both amateur radio operators and amateur radio stations is both sound and equitable."

Hiram Percy Maxim, President of the American Radio Relay League, presented a plea for amateur wireless toward the end of the hearing, stating that the proposed regulation disclosed a short-sighted policy on the side of the Government, unquestionably imperialistic and thoroughly un-American. He noted that in 1912 those who had erected small private wireless stations were given legal standing in the law under the name "amateurs." In a review of amateur operation he noted especially that the amateurs themselves undertook to reduce unnecessary interference and to set higher standards of efficiency; in fact at the outbreak of the war a proposal had been made to the Department of Commerce for the service of deputy inspectors, organized to report amateur violations as to power, wave length, wave purity and decrement. These inspectors were to be selected from the amateur ranks and to serve at a dollar a year.

In estimating the extent of the experimental interest in radio, he expressed a belief that there must have been 175,000 amateur wireless stations in this country at the outbreak of the war. Of transmitting licenses issued prior to the day of closing, the Commissioner of Navigation stated the actual number to be 8,562.



O. R. Terry's pre-war wireless station at Stoughton, Wis., another amateur assembly

broadly speaking, it was satisfactory to the organization he represented. On the question of government ownership, he stated, "We have no comment to make upon the question of Navy control and ownership of communication."

Congressman Burroughs of New Hampshire, inquired, in connection with the proposed amendment, whether the amateurs would not object to the requirement of 75 letters per minute in the Continental code. Mr. Maxim spoke for the American Radio Relay League as an organization, stating that they would not object to it. He noted further that the league's membership was only 4,000 members, and there were other amateurs beside them. It developed on questions from Congressman Edmonds, that second grade commercial operators were required to send but 12 words, or 60 letters, per minute, whereupon Mr. Maxim said the amendment's provision was too high, and that the required speed should be no higher than that for a second grade commercial license.

Congressman Green later referred to the government ownership provisions of the bill, stating: "This proposition as it comes before us is to broaden the opportunity of the Navy to go into commercial business and I want to know whether you amateurs have given any consideration to the fact of the Navy entering that field." Mr. Maxim replied that there was no comment to be made upon that at all, whereupon Congressman Edmonds inquired: "You do not think it will prevent boys from studying wireless because there is no place for them to go, if they want to make a business of it in the future?" Mr. Maxim said he could see where that might be used as an argument.

Mr. Green than referred to the plans of the Department of Commerce to develop foreign trade. Ascertaining that Mr. Maxim had not given any thought to that part of it, he gave the opinion: "you are bound up with the Navy to put this proposition through."

The Congressman stated that he was a great believer in the expansion of trade, and wanted to get something to show that this bill would promote that expansion. His understanding was that it was a contraction, that it meant contraction of trade, and he wanted Mr. Maxim's ideas on that point. The witness asserted that he did not feel himself competent to answer that question.

The question of the amendment's reduction of amateur power to ½ kilowatt was introduced by Mr. Edmonds. Mr. Maxim replied that he thought it a reasonable request to limit the amateurs to ½ kilowatt, and considered it a very healthy condition. As to the ¼ kilowatt within 5 miles of a government receiving station, he stated if evasion or advantage was taken of that provision, then he was opposed to it. This followed the supposition by Congressman Edmonds that a naval officer could install a receiving station in his home, and because the government paid the rent of the house it would technically become a government receiving station.

Mr. Maxim, in later discussion, withdrew his approval of the 75-letter-per-minute provision of the amendment, as it was developed that the intention had been to make this the same as the requirement of a second grade commercial operator, 60 letters per minute,

Estimates of the investment represented in amateur wireless stations were placed at ten million dollars. Five amateurs were named who respectively had invested in amateur apparatus for their individual use $5,000, $15,000, $2,500, $5,000 and $2,000. It was also emphasized that the majority of the amateurs in the country were men between the ages of 20 and 30; not, as popularly supposed, boys in short trousers. Twenty-eight electrical supply houses furnishing apparatus to amateurs were listed as typifying the extent of the industry which the law would, at a stroke, wipe out. He estimated the commercial capital they had invested to be from two to three million dollars.

The developments which accompanied wireless experimentation were exemplified by the case of an amateur who was working on a means for the separation of oxygen and nitrogen from the atmosphere, and another case where promising experiments were being made in the joining of metals, both suggested as the result of working an amateur station.

As to the war utility of amateur training, Mr. Maxim quoted from a letter written by a former amateur, who with two friends, enlisted together. "I was the only one of the three that had amateur experience. I finished the training of the electrical class, Brooklyn Navy Yard, in three weeks and went to sea. My two pals took seven months and they did not begin to know what I did." Lieut. Tuska is also on record, stating that in aircraft radio a man without previous experience required fifteen to sixteen weeks to become an operator, whereas an amateur was made ready for service in as few as one hundred hours.

A list of 51 former amateurs serving in the military establishment was introduced, to illustrate their value in time of war. Mr. Maxim then noted that in spite of the utility of experimenters, the bill introduced made not a single mention of the amateur, entirely eliminating him. "It is not satisfactory to us," he said, "to gloss over this question by explaining that the amateur is tacitly included under 'experimental stations.' Such an explanation is to our minds indirect, doubtful, and not what we regard as straightforward and square treatment. Such an arrangement would leave us at the mercy of unfriendly interpretation of the law."

Mr. Maxim, in the early part of his statement, urged the adoption of the amendments which referred to the amateur, and which were presented by the Navy Department. Congressman Bankhead of Alabama, inquired if this amendment was entirely satisfactory to the amateur interests; to which Mr. Maxim replied, On question, Congressman Hadley of Washington, developed that to Mr. Maxim, the situation was satisfactory if the bill was not passed, the amateur stating that it had been proven satisfactory by the last five years of experience. Mr. Hadley then had confirmation of his opinion that the proposed amendment had merely been offered for self-protection, to reconcile the difference between the amateurs and the Navy as proponents of the bill.

The administration of amateur wireless affairs in the hands of the Department of Commerce in the past had been cordial and satisfactory, Mr. Maxim agreed, and gave his judgment that they would like very much to go back to their "old love."

Francis F. Hamilton, representing the Hoosier Radio Club of Indianapolis, appeared before the Committee and stated that he had recently been an instructor in the Signal Corps. He reiterated the value of preliminary amateur experimentation in preparing men for military service. The first group of students which he handled had been nearly all amateur operators and became very proficient in military signaling when they were through that course. The next group knew nothing of amateur wireless, and after 13 weeks of training, they knew less than when they started.

He gave his opinion that one of the greatest benefits of amateur work was the fostering of ambition; "many amateurs dream of the day when they may be on a large ship at sea operating a wireless station," he said. "With that in view, what is the chance of amateurs operating ship stations after they have fulfilled the requirements, if this bill passes? Why, an amateur would have to join the Navy first, and put himself under military authority in order to develop his commercial profession and ambition!" It was his belief that the amateurs would not look upon this course as desirable.

In further opposition to government ownership, he stated that one who had a fundamental patent on radio apparatus would have no right to use it without giving it to the only bidder, who would be the Secretary of the Navy. Congressman Hadley interposed, "You want a broader market for the inventor?" Mr. Hamilton replied that he wanted a broader market than there would be if the bill should go through. Congressman Hadley then developed the opinion from Mr. Hamilton that private monopoly would be more liberal to inventors than a government monopoly, the thought being that the government was interested in public welfare, whereas private interest would be interested in getting the profit out of the patent. Mr. Hamilton instanced, as an illustration, the purchase by the Marconi Company of the patent of Professor Pupin. He expressed high hopes of amateurs inventing apparatus which would force the commercial companies to buy the improvements "if the wireless business is not bottled and corked up by the Navy Department as this bill proposes."

The Hoosier Club representative stated his belief that should the Congressmen on the Committee themselves become amateur operators, they would much rather be under the Department of Commerce than under the Navy, adding in reference to the amendment, "I want to go on record as stating that I do not see any valid reason why the present law should be changed."

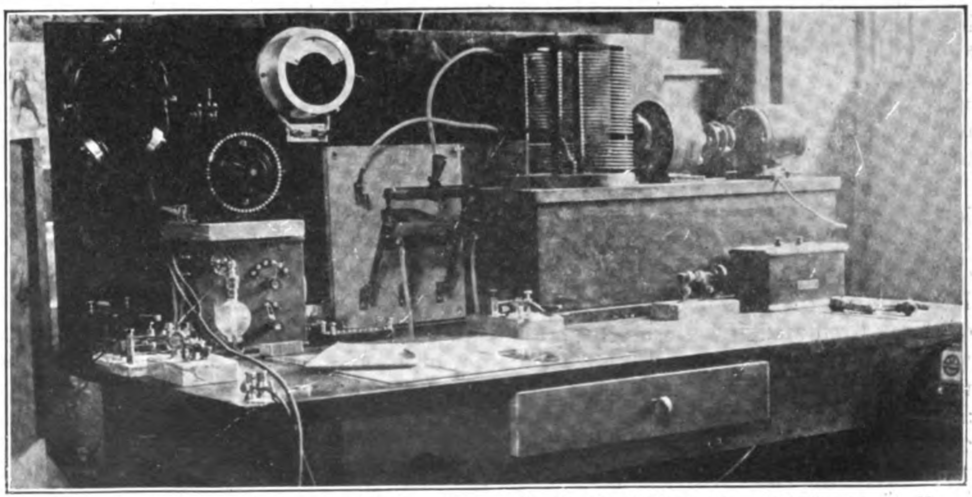
Congressman Hadley said that it was represented to the Committee that the amendment represented an agreement which was satisfactory to both sides. "Mr. Maxim represents a certain number of amateurs," Mr. Hamilton replied. But "each amateur is a little company of his own and each man will have his own ideas. I think that Mr. Maxim said himself that if it were possible he would like to see the law left as it is, but if it were not possible to do that, he would agree to this amendment."

Mr. Hamilton also discussed some of the phraseology of the proposed amendment, disclosing that it did not permit experimentation for profit. On the questioning of licensing receiving stations, he had no objection, but he thought that 50 letters a minute, or 10 words, was "plenty strong enough a requirement." "We do not want these people to be experts," he said; "the old law requires 25 letters per minute but we are willing to make it 50." He further noted that the amendment limited amateurs to ¼ kilowatt within 5 miles of any governmental receiving station. This provision he believed would apply to a station which had been established in the Post Office building in Indianapolis, which he instanced as the likely forerunner of many more receiving stations to be placed on Post Office buildings. He stated that the amateurs he represented would not agree to accept an amendment of this kind. The possibility of the Post Office Department extending its service and putting receiving stations on Post Office buildings in cities of any size should be anticipated.

As particularly limiting the amateurs to ¼ kilowatt, a communication from the Baltimore Radio Club was offered, stating that the members would agree to 12 words per minute, but were opposed to limiting the amateurs to ¼ kilowatt within 5 miles of a government receiving station.

Congressman Humphreys asked Mr. Hamilton's opinion on the creation of a commission to determine wave length and power to be used by amateurs. Mr. Hamilton reiterated that the present law was satisfactory and sufficient. Congressman Green observed: "As I understand it, the amateur is satisfied with the present law, which they had before the war. They have been efficient in the war, and now they want to go back to their former position, and here comes a new law that ties them up so they cannot get back to where they were. I cannot see any reason, after they have rendered good service to the government, why they should not have a chance to return to their former status."

"That is absolutely the condition," confirmed Mr.



Amateur wireless station operated before the war by A. M. Lindsay, Jr., of Rochester, N. Y.

Hamilton. "None of these amateurs would be here today if that bill had not been written so that it would cut them clear out. The Department of Commerce has treated us fine and we have always gotten along well with them. There is no reason why we should change, that I can see. There is no objection to the existing law."

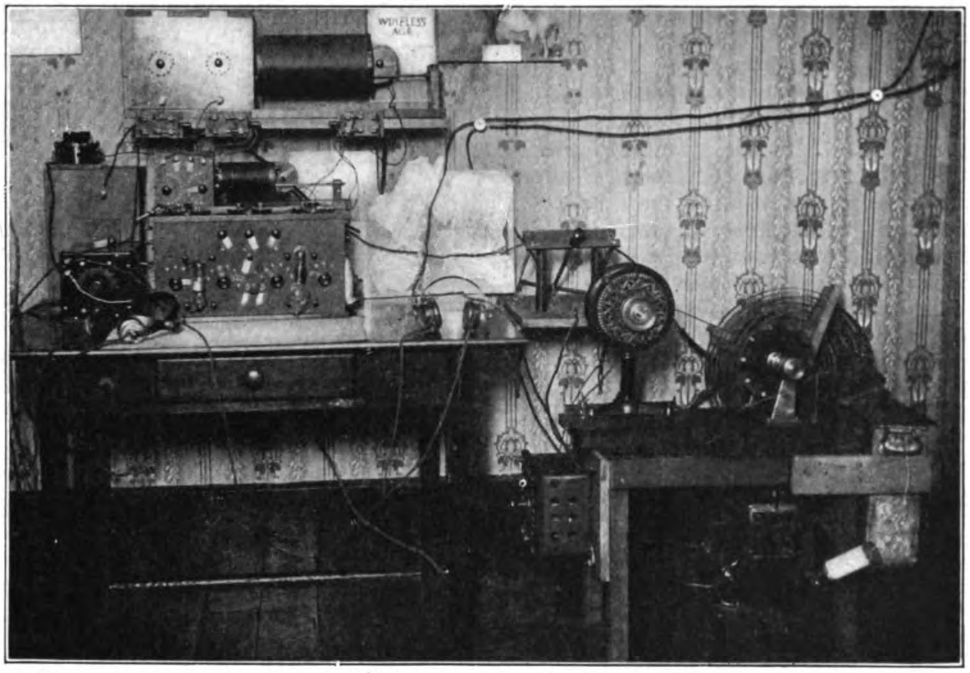
The next amateur opponent to appear was Edward C. Andrews, president of the Wireless Association of Pennsylvania, who stated they were "unalterably opposed to the change in the present law. We see absolutely no reason for it," he exclaimed, "and lots of reasons against it." The paramount reason was that the Navy sponsored it.

The bill would remove the incentive for experiment, he believed. Experimenters "would have to enlist in the Navy in order to carry on the studies they have undertaken," and "if we have no incentive and no place for any one to go and sell apparatus, naturally that puts an end to experimentation," were two of his pertinent utterances in opposing naval monopoly.

Dr. Gordon M. Christine followed Mr. Andrews. He explained that medicine was his profession, and his age was 61, but he was an amateur in wireless telegraphy and had become intensely interested in the art. The work should go on as it was before the war, in his opinion, and he could not understand why power should be reduced to ¼ kilowatt in the amendment to the bill. "We do not like this amendment; we do not want any amendment at all!" he added with emphasis. "Give us this old law. Do not disturb that."

Congressman Beshlin inquired for the Doctor's opinion as to the difference in control by the Department of Commerce and the Navy Department. "My own opinion," he replied, "is that the treatment which the Department of Commerce has given us has been that of man to man; and the treatment which the Navy would give us would be the treatment of a high official to a civilian." Many amateurs seemed to be more afraid of naval authorities than civil branches of the government, stated Congressman Humphreys, referring to the proposed control. "I believe that the Navy has it in for the amateur and wants him out," was the answer returned by Dr. Christine. It would not have presented the original bill if it did not, he thought. "But they became somewhat alarmed at the tremendous uprising of the amateur throughout this country at the prospect of being deprived of their outfits." Questioned by Congressman Hardy, the physician said that the language of the original bill led him to believe that the Navy had something against the amateur.

Congressman Edmonds thought the objection reasonable. "The Department of Commerce is a business department," he said, "and it is used to handling business, and in its report it speaks very highly of the amateur operators. Undoubtedly they have got along very well together, and I do not blame the amateur operators for coming here and objecting to a change in the departments. If I were they, I would do the same thing myself, because they know what they can get from the Department of Commerce and do not know what they can get from the Navy Department."


Wireless station owned and operated before the war by Mr. and Mrs. C. Candler of St. Marys, Ohio

Joseph Heinrich, a thirteen year old amateur of Washington, received a cordial reception for his courage in appearing before the Committee. The boy put in a strong plea for the rights of the amateur and received the assurance that the Congressmen were not unfriendly.

Charles H. Stewart, of St. Davids, Pa., who has previously appeared for the amateur in opposition to prohibitive legislation, made a brief address. He seconded the expressions on the matter of leaving wireless under the Department of Commerce and noted that operating speeds for sending station licenses could be changed by regulation, no further law being required to do this.

Harry W. Densham, secretary of the South Jersey Radio Association, confirmed what his predecessors had said in opposition to the bill.

Frank B. Chambers, of Philadelphia, added to the testimony for the amateurs, illuminating various points discussed by amusing and graphic word pictures. He also objected strongly to Navy control, and echoed the consensus of opinion that the present law should remain in force without alteration.

(*Continued on Page* 44.)

Experimenters' World

Pertinent Suggestions for the Experimenter's Workshop

By E. T. Jones

Experimental Carbon Amplifier

THE description of an amplifier for radio signals I constructed as follows:

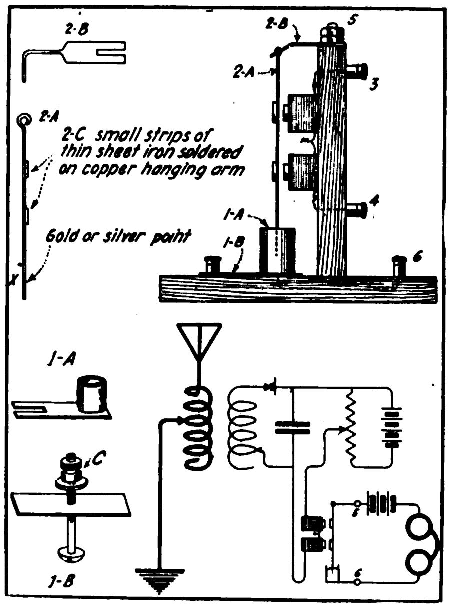

2-B
2-B
5
2-A
3
2-A
2-C small strips of thin sheet iron soldered on copper hanging arm
1-A
4
Gold or silver point
1-B
6
x
1-A
C
1-B

Figure 1—Detailed plan of construction and circuit of the carbon amplifier

Two magnets from a 1,000 ohm receiver are mounted as shown in figure 1 and suitable connections thereto provided by the binding posts 3 and 4. On the base is mounted the cup which holds the carbon granules. It is made adjustable by providing a slotted strip of brass as shown at 1-a which slides over and makes contact with the brass strip 1-b and is held or clamped when the desired adjustment is obtained by the locknut c. The dipping arm 2-a is made of copper wire about No. 24 preferably gold pointed (at x the part which dips into the granules can be gold plated or a small piece of gold wire soldered thereon). The top of this No. 24 wire is bent so as to form a circle and fits on the arm support 2-b which allows it to move freely. The end of this dipping arm is allowed to rest in the cup, 1-a of carbon granules. The arm support 2-b is fastened to the same support which holds the magnets and a binding post is supplied to furnish a connection from the dipping arm through the cup. The detail 2-c is made of two strips of iron which act as armatures for the telephone magnets. They are soldered on the copper hanging arm which dips into the carbon granules.

This amplifier when properly constructed works exceedingly well, and owing to the fact that it is simple in construction there is no reason why pains should not be taken to make as good a job as is possible with the material at hand.

Under actual working conditions the amplifier functioned with a signal whose audibility was a little more than 100. The dipping needle if not provided with a silver or gold point will not work as well, and will have to be constantly cleaned. Better results were obtained by inserting another receiver of 1,000 ohms in series with the two mounted magnets making in all 2,000 ohms. The carbon granules should be of the finest grade and the inside of the cup or retainer should be kept clean. From time to time it is well to remove the granules and clean them. If it is possible to get several of these amplifiers to function efficiently, then the cascade connection can be resorted to for further amplification. As an experimental instrument this is a good one but there is plenty of room for improvements in connection therewith.

A Magnetic Rectifier for Alternating Currents

A magnetic apparatus for A. C. rectification is shown in figure 2. A permanent bar magnet (marked N and S) is pivoted at the center by drilling a hole through the bar and passing an 8/32 screw through same. Both ends rest in the holes made in support A. The magnet B is taken from any old sounder or constructed along that size throughout. This is in turn put in series with the 16 C. P. carbon lamp C so as to prevent the windings from burning out and at the same time perform its duty. Two contacts are furnished which are insulated from other parts of the mechanism D and E.

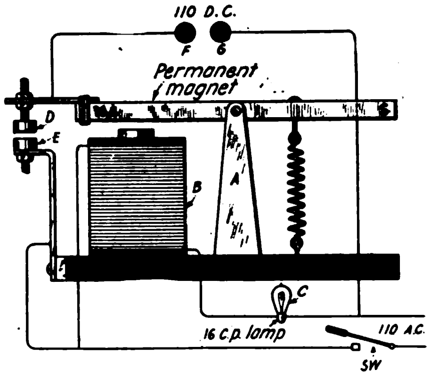


Figure 2—Construction of magnetic rectifier for alternating currents

The apparatus works on the fundamental law of magnetism; LIKE POLES REPEL and UNLIKE POLES ATTRACT. The alternating current flowing through the magnet B changes the poles of its core according to the frequency of the current entering its windings. But at the same time the steel bar magnet retains its poles. The result is that when the current entering the magnet produces a north pole at the top end of the electro-magnet there is no attraction, since like poles repel, but on the other half of the cycle the poles of the electro-magnet are reversed and the top end is made a south pole. Then the law holds good that unlike poles attract thereby drawing the two contacts D and E together causing current to flow through the contacts F and G as direct current. This performance continues so long as the current is turned on at H.

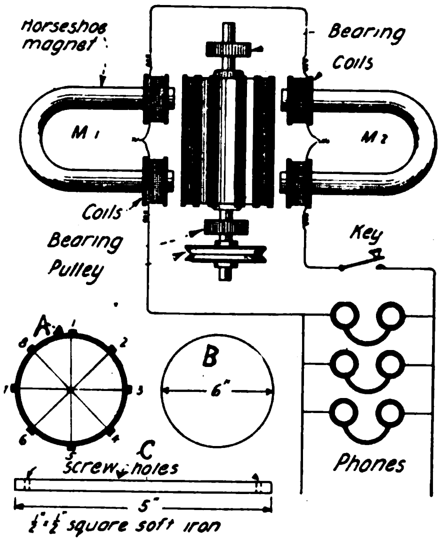


Figure 3—Diagram of construction and circuit of the high frequency generator

An Economical and Efficient High Frequency Generator for Code Practice

Having had the pleasure all these years of experimenting with several types of buzzers I have found that the contact points always burn out after any considerable use, and numerous other troubles present themselves. I have constructed a form of high frequency generator which gives a clear note of constant amplitude in the telephones and has many advantages which are only to be appreciated under operation. Means should be provided to regulate the strength of signals in the head telephones according to the number of head sets on the line.

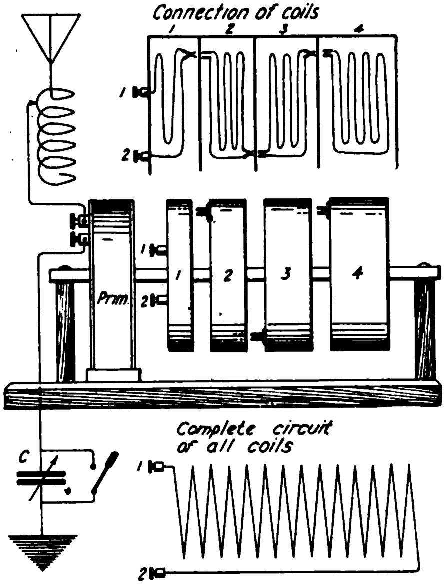


Figure 4—Design and connections of the complete receiving transformer

It is also possible to take off parallel wires and run them to the various tables in series with the ordinary telegraph key for each table.

The apparatus completed is shown in figure 3 where a drum as in detail B is constructed of two round ends of wood 6" in diameter and about 1" thick upon which are mounted bars of soft iron ½" by ½" thick and 5" long. A suitable shaft is run through the centre and two bearing supports are provided together with means for oiling. As is seen in detail A, eight iron bars spaced evenly apart are screwed to the wood ends. This drum is rotated between the two horseshoe magnets M-1 and M-2 upon which have been wound coils consisting each of 200 turns of No. 28 D.C.C. wire. Magnet M-1 is adjusted to have its magnetic circuit completed by the movable iron bar just after magnet M-2 has had its magnetic circuit broken. This gives double the frequency to be obtained with one horseshoe magnet. A suitable pulley about two inches in diameter is mounted on the drum and and a five inch pulley on the motor turning 1500 R.P.M.

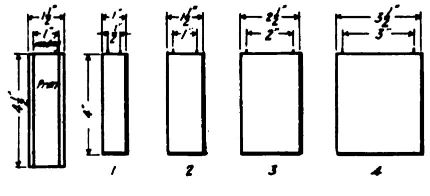


Figure 5—Showing dimensions of primary and secondary coils and their windings

In practice considerable frictional losses were experienced owing to the fact that I did not have good bearings and means for oiling them continuously. Therefore, it is wise to benefit from my experience and secure good bearings and an adequate oiling system. As a whole the apparatus is very interesting under operation and provides a means for demonstrating the principles of alternating currents to students during lecture periods.

An Up-to-Date Receiving Transformer

Radio fans are on pinions waiting for the word GO from our Government. Many will construct as the first part of their equipment a receiving transformer. I believe that the design shown in figures 4, 5 and 6 which I have tried out will be a valuable adjunct to their station. This tuner is fitted with a primary coil consisting of thirty turns of wire, this number being sufficient for general practice. Further variation of wave length in the antenna circuit is secured by the loading coil L, external to the transformer. Response from short waves can be secured by means of the series variable condenser C.

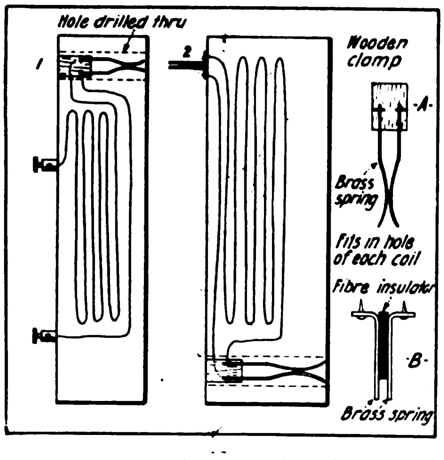


Figure 6—Detailed construction of the plug switch

It is to be especially observed that the secondary winding is broken into four units and means are provided whereby they can be connected together by means of a special plug. The primary winding is made on a form, 4½" in diameter, 1½" in length, wound for 1" with 30 turns of No. 22 DCC wire. Approximately 35 feet are required.

The first coil in the secondary is 4" in diameter, 1" in length, wound for ½" with 22 turns of No. 28 DCC wire. Twenty-four feet are required. Secondary unit No. 2 is 4" in diameter, 1½" in length, wound for 1" with 45 turns of No. 28 DCC wire. Forty-seven feet will be required. Secondary unit No. 3 is 4" in diameter, 2½" in length, wound for 2" with 90 turns of No. 28 DCC wire. Ninety-four feet are required. Secondary unit No. 4 is 4" in diameter, 3½" in length wound for 3" with 135 turns of No. 28 DCC wire. One hundred forty-one feet will be required. The total secondary therefore will consist of 292 turns or 306 feet of No. 28 DCC wire. The measurement of all parts are shown fully in figure 5 and the details of the plug switch at A and B in figure 6.

If desired additional secondary units can be provided. Each successive coil should be larger than the preceding one as in the design already shown.

A suitable shunt condenser must be connected across the secondary. In this way, a closeness of adjustment not possible with the secondary inductance alone, can be obtained. The principal advantage of my design is that the unused turns for a small range of wave lengths are disconnected from the used turns which, as is well known, increases the efficiency to a remarkable degree.

A Modulator of Continuous Oscillations

THE successful reception of signals from stations emitting undamped waves requires some means for reducing the radio frequency currents to audio frequency currents of less than 20,000 cycles per second. This can be accomplished in a number of ways, such as by the use of a tikker that breaks the circuit at a speed great enough to give an easily read note in the receivers, by utilizing an interfering current to produce "beats" or current peaks as in the heterodyne system, or by tuning and detuning the circuit at high speed to give an audible note.

The latter method has received little attention from experimenters and should be a fertile field for investigation. The revolving condenser method has been described previously but the instrument described in this paper uses an inductance to tune and detune the circuits. The device is nothing more than a small variometer so constructed that the inner coil can be revolved at a high speed.

In figure 1, is given a broken view of the device to show its assembly. The constructional details and dimensions are given in figure 2. A square, wooden frame is used to support the stationary coils. This should be assembled with small brass screws, one end being left off till the rotor is in place. Bearings for the rotor are made from brass and mounted in the ends as shown.

The rotor is made from a two inch

length of shade roller or other wooden stick one inch in diameter. A slot one-quarter inch square is cut in opposite sides to take the winding. Holes are drilled in the ends to take one-quarter inch brass rods of the lengths given to form a shaft. Grooves are cut around the rotor for the fine silk or linen binders that hold the winding in place.

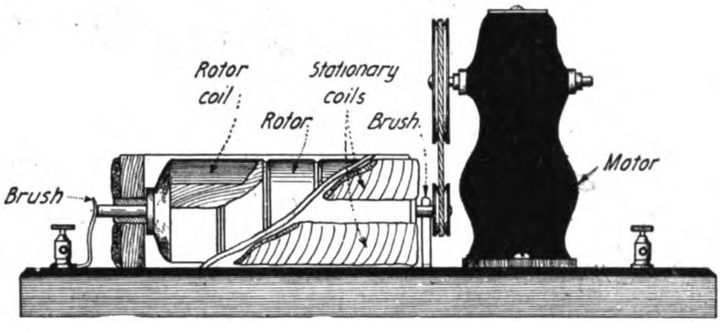


Figure 1—Assembled view of device for modulating continuous oscillations

The rotor is wound with No. 28 B & S, S.C.C. copper wire. One end of the wire is soldered to one shaft and the wire wound around in the slots similar to a telephone magneto. A little tape should be placed around the shaft where the wire touches. The winding is done in smooth layers, a slip of thin pasteboard being put between layers to keep them smooth and reduce the capacity effect of the winding. When the slots are full the other end of the wire is soldered to the other shaft. A piece of cardboard is put in each slot over the winding and then bound in place with fine silk thread.

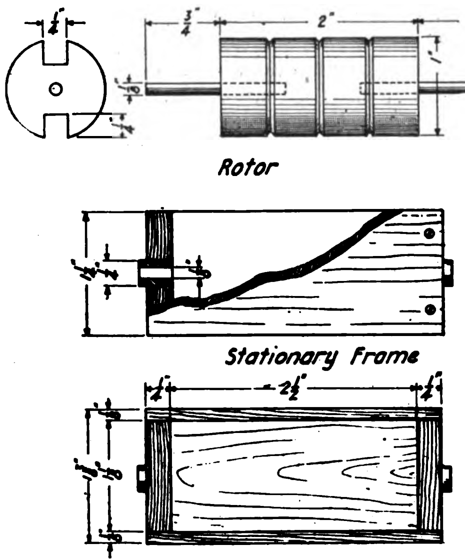


Figure 2

Figure 2—Showing constructional details and dimensions

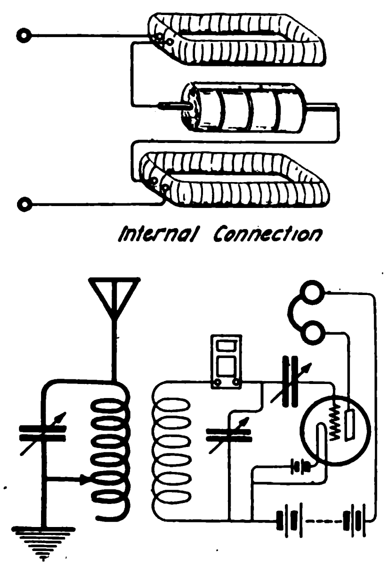


Figure 3

Figure 3—Showing method of wiring the device in the receiving circuit

The stationary coils may be wound right on the square frame after the rotor has been put in place but it is preferable to make them so they can be easily removed. Each coil of the stationary winding should contain one-half the number of turns on the rotor, they being made of the same size wire. The form used for winding them should be a trifle larger than the square frame, a winding space three-eighths of an inch wide being used. Thin pasteboard should be placed between layers to stiffen the coils and also reduce capacity losses. After being removed from the form the coils are served with a layer of tape to keep them in shape.

The motor used for driving the rotor should be of the series type to give a high speed which can be controlled by a small rheostat. A heavy rubber band forms a very satisfactory belt for the device.

The usual method of wiring this instrument in the receiving circuit is shown in figure 3. By bringing out the leads from the rotor and stator to separate binding posts the experimental possibilities of the device are greatly increased.

Thos. W. Benson, *Pennsylvania*

Long Wave Variometer

The variometer possesses a number of features that make it suitable for close tuning but the conventional type with concentric coils limit the range of wave length over which it is possible to tune. This is due mainly to the fact that the winding space must be made very narrow if the coils are to fit closely. Increasing the space results in an instrument with the coils so widely separated that the range is limited and quite a lot of inductance remains in the circuit when tuned to the lowest point on the scale. Realizing the advantages of close tuning and lack of end-turns, the writer has designed an instrument with these advantages that will respond to the higher wave lengths.

This type of variometer can be built for any range of wave length with the simplest of tools. The instrument described will work up to 10,000 meters and is intended for use in oscillating or Armstrong circuits, as a plate circuit loading coil.

Instead of two concentric windings it employs four coils so mounted that by revolving two of them about an axis their magnetic lines can be made to assist or oppose those of the stationary coils and thus obtain a gradual variation of inductance without any dead wire in the circuit. The dimensions of the coils can be changed to suit conditions, the instrument described being merely an example of this type of instrument.

The four coils are all similar in construction, being wound on wooden cores three inches in diameter and two inches long. Heads four inches in diameter are cut from thin fibre and fitted to the ends with glue and brass pins.

The winding is put on in four layers. The first being wound on the core, then a strip of corrugated board being cut to fit snugly around the winding and put in place. Four layers will fill the coils.

The method of assembling the coils is shown in the illustration. The cabinet used with the above coils should measure 9 x 9 x 5¼ inches inside. Two of the coils A and A-1 are mounted on the back, one above the other with a space of ¼ inch between them to pass the brass rod E forming the axis for the movable coils. The windings of these coils are so connected that when viewed from one end the current will flow around them in opposite directions.

A sheet of thin fibre or stiff pasteboard with a ¼ inch hole in the center is fitted into the box in front of the coils to form a smooth surface over which the coils B and B-1 can turn. The moving coils are fastened to a strip of wood D, ¼ inch thick,

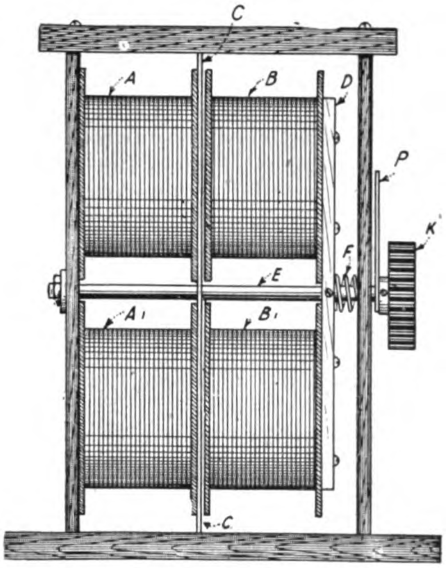


Figure 1—Showing method of assembling the coils of the long wave variometer

½ inch wide and 7¼ inches long. When mounted the coils have a space of ¼ inch between them at which point a hole is drilled in the wood strip to pass the brass rod. A small wood screw is put in one side of the strip opposite the hole to clamp the strip to the brass rod. The connections of the moving coils is similar to that of the fixed coils, so that the current will flow around them in opposite directions. Flexible leads are used to make connections to these coils.

The instrument can be completely assembled by passing the brass rod through the back of the cabinet and the fibre sheet, and slipping the strip over the rod so the coils rest against the separator, making sure to clamp coils B and B-1 by means of the small screw provided.

The four coils are then connected in series, with leads brought out to binding posts. The small spring F is slipped over the rod and the front of the cabinet put in place. A knob and pointer are attached to the projecting end of this rod to operate the instrument. A scale is mounted on the front of the cabinet. This is in the form of a semi-circle since one half-turn will vary the inductance from minimum to maximum. The pointer should be attached in such a position that when at the highest point of the scale the coils are in such a position that the current will flow around both top coils in one direction and around the lower ones in the opposite direction.

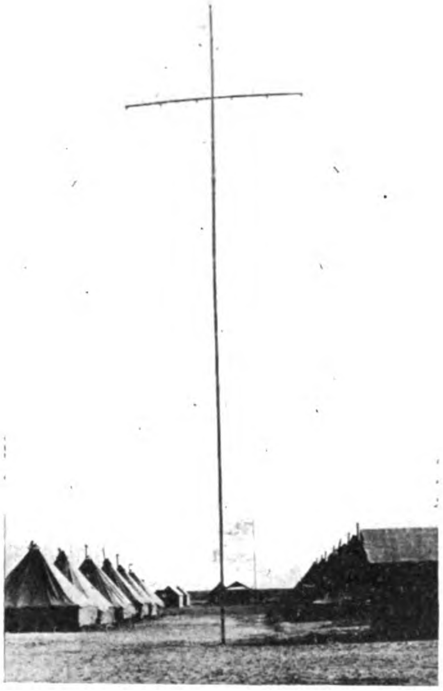
The instrument is now complete and ready for use. By bringing out separate leads from the coils numerous experiments are possible that will make the instrument a favorite of the experimenter.

Thos. W. Benson—*Pennsylvania.*

U. S. Signal Corps Radio Station

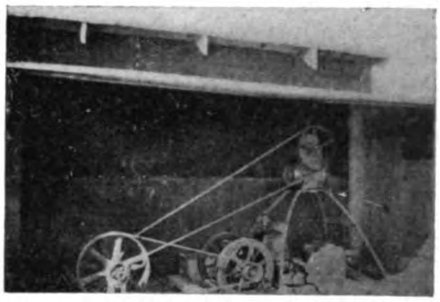
The camp station of the Radio Co., 1st Pennsylvania Signal Troops, while quartered at Camp Stewart, El Paso, Texas, is shown in the accompanying photographs. Particular attention is directed to our method of driving a pack set generator with an engine rather than by hand. This method gave very excellent results.

The masts are 60 feet in height and the span 350 feet in length. Using ¼ kw. pack set excellent signals were received at Colona, Dublan and El Valle in the daylight hours over a distance of 160 miles. Press and time signals were received from Radio, Va., every night and practically all commercial stations on the Atlantic and Pacific coasts were heard at one time or another.



The masts were 60 feet high and had a span of 350 feet in length

K. B. Haines, *Pennsylvania*



Novel method of driving a pack set generator with an engine instead of by hand power

My Views of the Amateur Situation

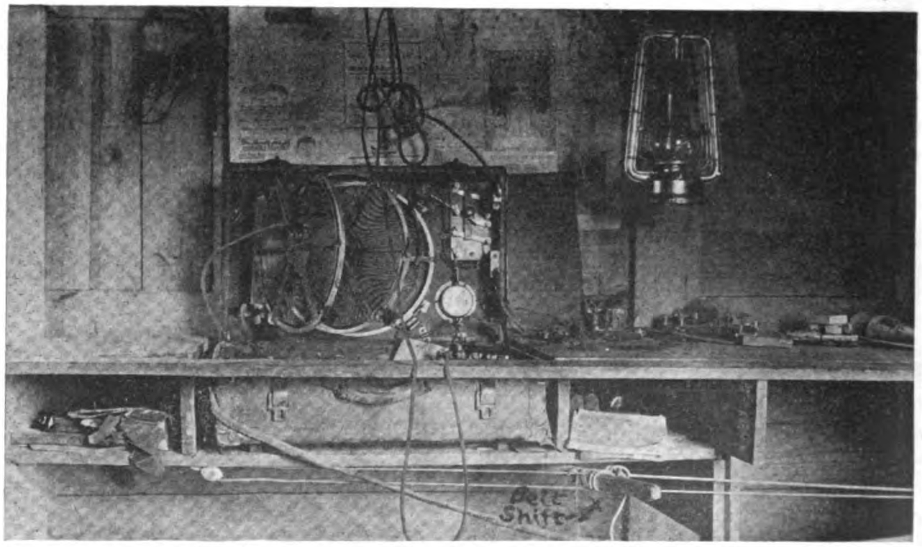
Close observation of the pre-war operations of amateur stations indicates to me that some changes in the methods of licensing are desirable.

I believe the situation can be improved in respect to power input, wave length and licensing of the operator. For example, I would suggest that the owner of a 1-kw. station not in proximity to military or naval stations, be required to hold a second grade commercial license. This would give the assurance that the owner has a far better working knowledge of his apparatus than the average amateur and it is reasonable to assume that he would not misuse the power of his station to create unnecessary interference.

Those unable to qualify for a second grade certificate should be placed in class 7 under the former Radio Laws. In most cases this class includes younger boys who are not interested in the art from a scientific standpoint. I believe your readers will agree with me that this plan will eliminate to a marked degree interference between 200 meter stations.

The owners of stations put in class 7 will thus be given an incentive to improve their ability as an operator and to increase the power and wave of his station.

L. N. Way—"9XD."



Interior of wireless station at Camp Stewart, El Paso, Tex.

The Layout of the Ideal Amateur Station

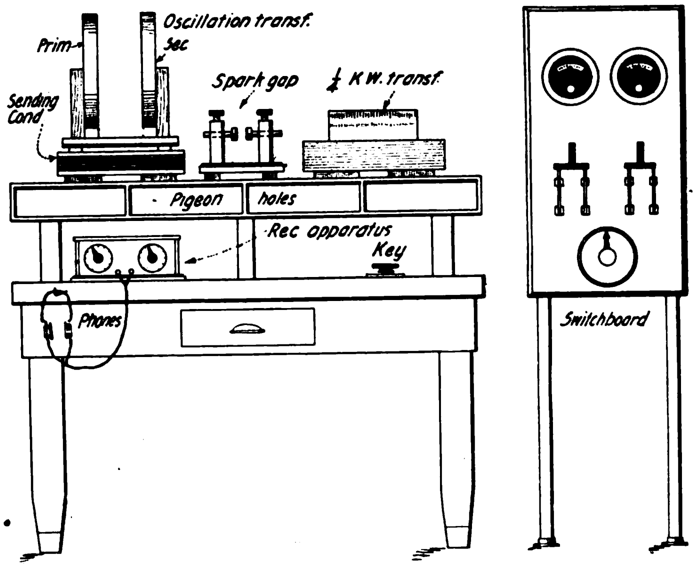


Figure 1—Plan of an amateur station of the detached instrument type

SOME of your contributors will undoubtedly state at great length the technical requirements of the ideal amateur station, but I will discuss the matter from the view-point of accessibility of apparatus and ease of operation. Amateurs frequently are at a loss how to go about installing their apparatus in a manner that will fulfill these conditions; and while all of us have other ideas on this subject, my years of experience in radio work leads me to believe that the accompanying drawing gives a plan of an amateur station of the detached instrument type that will work towards all-around efficiency and permit the greatest ease of manipulation.

The reader will note that on the top of the pigeon holes which is to retain the message blanks and other stationery, I have mounted the principle elements of the transmitting set, the high voltage transformer, the spark gap and an inductively coupled high frequency oscillation transformer. Immediately to the left of the table is placed an inductively coupled receiving tuner which in the up-to-date station will be fitted with a vacuum tube detector, and at the right the transmitting key in a place convenient to the operator. The switchboard to the extreme right of the table should contain the volt meter and ammeter, a switch for turning on and off the power, and a reactance regulator for controlling the primary current.

This lay-out in addition to presenting a neat appearance permits the shortest possible connections between the elements of the closed oscillation circuit.

The general specifications of the spark transmitter are so well known to the amateur field that we need not enter into a discussion of the problems here. It is believed that if the plan I present is adopted by the rising experimenter, it will prove of great advantage to successful operation.

E. T. Jones—*Louisiana.*

A Plan for Organization

(*Continued from page 23.*)

regulations prescribed, the rest could be banned and their methods advertised.

The publicity committee, being an important one, should have a capable executive as chairman, the balance of the personnel being selected from members of the other committees, so each division of committee activities would receive its full share of publicity. The State organizations' activities should then be actively covered—and with clocklike regularity—by reports sent to the magazines interested in wireless, provided interesting items were sent to the press regularly.

The subject of raising funds is a pertinent and vital one. Anyone who has had experience with local or State clubs knows how difficult a matter this one is. Ninety per cent of the trouble, however, is due to the fact that service of actual value to the amateur must be rendered if it is expected of him that he continue to pay dues. Numerical membership increases are largely dependent upon the dues being low, yet it is obvious that expenses increase as the membership grows. If dues are placed at a high figure, few care to join and the puropse of the organization—wide mutual benefit—is defeated.

On the State organization proposition it does not seem practical to look for local clubs to contribute out of their treasuries; they are usually long on enthusiasm but short on cash. Local clubs usually have a sufficiency of financial troubles and are not in a position to help out, even if entirely willing to do so. So, for a State organization, an endowment fund seems a necessity. To secure endowments, it is necessary to incorporate under the State laws. A faultless constitution is also necessary; one that financiers will pass upon without question. Two honorary grades of membership should be provided for, to be bestowed on public-spirited citizens who contribute $50 or $100, or more, to the endowment fund. These men need not necessarily be interested in science; the membership and publicity committees should co-operate closely in connecting with and convincing men of means that their support will greatly benefit a body of serious-minded students of the wireless art. Funds can be raised by endowment, if this course is carefully pursued, which will aggregate a sum ample for all expenses to be paid out of the interest received by wise investment of the principal.

Other than the honorary membership, the Association should have two grades for amateurs, the highest (member) to consist of those who secure Commercial 1st Grade licenses, or the equivalent in experience; and a second grade (associates) comprising the beginners in the art who may later develop into candidates for the higher grade. Standards of membership should never be lowered. Exactly what these standards should consist of and the benefits under each grade, should be determined by the board of directors, as conditions vary in States and various parts of the country.

State organizations could render valuable service through the research and development committee carefully investigating all apparatus on the market. Values and costs of amateur equipment should be thoroughly digested for the information of members, particularly newcomers in amateur wireless, and advice on systems best suited to needs and pocketbooks given free of charge. This committee should also report to the central, or national body, fraudulent practices or misrepresented apparatus so the national body can secure a refund or replacement where poor apparatus has been received by the individual. This plan has been successfully carried out by the N. W. A. and is a valuable service to amateurs.

It is about time to start the ball a-rolling. It is suggested that amateurs begin now to get in touch with as many prominent amateurs as possible and exchange views and formulate plans. In this way the details will be classified when the time comes for State organizations to adopt a platform that, in main essentials, will conform to conditions throughout the country.

I should like to see a thorough discussion of this subject by amateurs in the columns of The Wireless Age.

Ralph Batcher, 9 YI

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A High Voltage Storage Battery for the Audion

One of the principal drawbacks of the vacuum valve detector for amateur use is the expense of keeping up the high voltage battery. The constructional details of a storage battery of about 60 volts follows. The battery may be charged from 110 volts A.C. by placing it in series with a 75 watt lamp and a one jar rectifier of the electrolytic type.

For the stand in figure 1, take two boards about 31 x 4 x ¾ inches and bore in each thirty one-inch holes, in two rows, the holes being one inch apart.

Two of the strips should be cut in half, these being used at the ends of the two rows.

For the containers use thirty test tubes 1 x 6 inches. Set the test tubes in the rack and place the lead strips in their proper positions, so that a positive and a negative plate are in each tube. (Figure 4.)

Some difficulty may be experienced in keeping the strips of lead an equal distance apart in the tubes. However, this may be overcome by taking pieces of heavy cardboard, previously soaked in silicate of soda and dried, placing them between the plates.

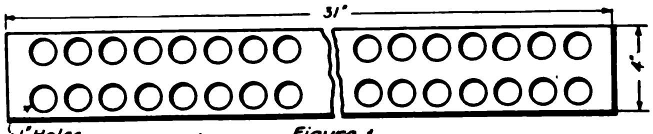

Figure 1

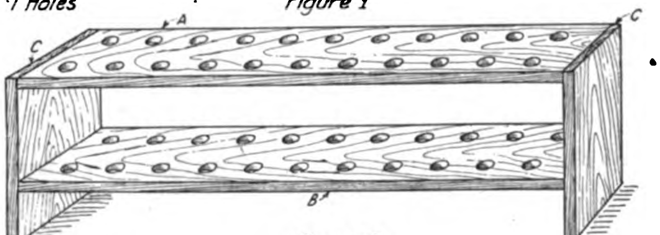

Figure 2

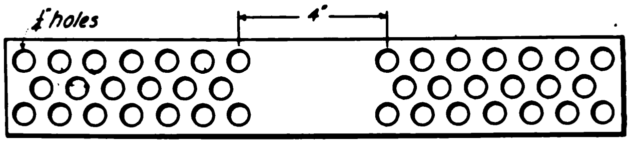

Figure 3

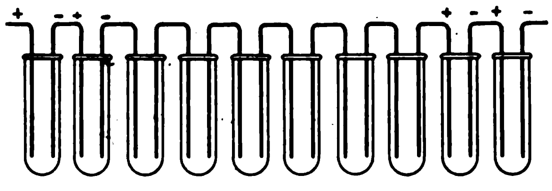

Figure 4

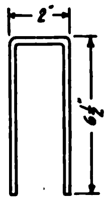

Figure 5

Diagrams showing construction plans of the various parts of the high voltage storage battery

Now take two pieces of wood 8 x 4 x ¾ inches and by means of one-inch wood screws, complete the stand as in figure 2. The shelf A should be flush with the tops of the end pieces CC, and shelf B should be about four inches below A. The frame should now be well coated with hot paraffine.

Cut thirty pieces of lead 15 x ¾ x ⅛ inches, and then using a ¼-inch drill, bore the lead strips full of holes, except for four inches in the middle of each strip as in figure 3.

Next bend the strips as shown in figure 5. Take a little red lead, and make a paste with a 10% solution of C.P. H_2SO_4. In one end of each strip fill the holes with the red lead paste, and in the opposite end of each strip fill the holes with a similarly prepared paste of yellow lead. These form the negative and positive plates, respectively.

The two rows of cells should be connected in series with a small lead strip.

When this is done, fill each tube to within ½ inch from the top with a 20% solution of C.P. H_2SO_4. The tops of the test tubes and the parts of the plates above the electrolyte should be painted with hot paraffine to prevent the acid from creeping.

The battery is now ready for charging and should be connected to a source of direct current of from 65 to 75 volts. The charging rate of this size battery is from ½ to 1 ampere, and the capacity is about 2 ampere hours.

Care should be taken to see that the battery is never run down, and that the electrolyte is kept at ½ inch from the top of the tubes.

Shelby J. Blong, *California*.

Contest Winners for the February Issue

In response to the call in the November issue for manuscripts concerning the ideal amateur set, prizes have been awarded to the writers of the following articles. The suggestion upon which the contest was based was: "AFTER THE WAR, WHAT IN YOUR OPINION WILL CONSTITUTE THE IDEAL AMATEUR TRANSMITTER AND RECEIVER?"

First Prize—General Specifications of an Ideal Amateur Transmitter and Receiver

THE ideal amateur wireless station should be, if possible, located on the ground floor of a building. If above the first floor, the ground wire may be so long as to cause some loss of radiation. On the other hand, if located in the basement, the lead-in where it enters the building will be too close to the ground and in some cases may cause a serious brush discharge to the earth.

THE AERIAL

The aerial should consist of six or more stranded copper wires, spaced at least four feet apart. A 10½″ hard rubber or bakelite insulator should be placed in the end of each wire. Insulators should be placed every fifteen or twenty feet in the guy wires to prevent loss of current to ground.

EARTH PLATE

A good earth connection is formed by burying squares of copper or tin sheeting about eight feet beneath the ground, in a circle of fifteen or twenty feet and bringing the connections from the plates in a rat-tail formation to the surface where the ground wire to the apparatus is attached. The ground wire should be at least a No. 4 stranded cable. The plates should be placed flat on the ground as it has been found by several amateurs that they work better than if they are placed on edge.

POWER

Care should be taken when wiring the station to run the lighting wires as near right angles to the aerial as possible, to prevent destructive currents from being set up in the power circuits. All wiring should be done in accordance with the underwriters' specifications, which can be obtained from any local electric light company.

THE TRANSFORMER

The transformer should be both substantial and efficient, and the voltage should approximate 20,000, in order that a small condenser may be used to permit the use of a reasonable amount of power on the 200 meter wave. A transformer with considerable magnetic leakage should be used as it can be adjusted to resonance and will not pull heavily on the lighting circuits.

THE CONDENSER

A good oil-immersed condenser for a ½ to 1 kilowatt transmitter may be constructed as follows: Obtain 10 plates of triple thickness glass each 9″ by 12″; coat eight of them on both sides, and two of them on one side each with heavy tinfoil 6″ x 9″. The lugs and foil are to be cut in one piece. Corners should be rounded to prevent brushing. Shellac can be used for the adhesive, and pieces of fifteen ply cardboard 6″ x 9″ in size should be placed between the plates for separation, so the oil can get between the plates. Be sure to cut the foil so as to bring the lugs out wherever convenient; then after squaring the plates evenly, tape them together tightly and place them in a box of transformer oil, on their edge, so the oil will force the air-bubbles out between the plates. The box can be made oiltight by pouring boiled sealing-wax along the cracks and letting it harden, then giving it a few coats of shellac.

THE SPARK GAP

The Marconi type of discharger is simple and efficient. On the shaft of a 1/10 h.p., 3,600 r.p.m. induction motor, mount a 10″ "Victor" record with eight equally spaced holes drilled around the periphery about ½″ from the edge, large enough to insert a battery binding post bolt. Then obtain some battery binding posts; file off their heads; put them in these holes and fasten them with small nuts on both sides of the disc. The stationary electrodes should be so placed that the rotary plugs will pass between them. This gap gives an excellent tone.

THE OSCILLATION TRANSFORMER

The oscillation transformer should be of the "pancake" type with 5 turns of No. 6 and 10 turns of No. 8 copper wire, or 1½″ ribbon (copper), for the primary and secondary, respectively. The frame should be made of "Bakelite" or well seasoned wood, and must be constructed so that the primary and secondary windings are accessible to the clips at nearly all points.

All leads connecting together the elements of the closed oscillation circuit should be as short and as heavy as possible. They should have no sharp bends or kinks in them.

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The Antenna Switch

The antenna switch should be so constructed that when in sending position it connects the aerial to the oscillation transformer; closes the circuit to the current mains and starts the rotary. When receiving, it should connect the receiving tuner to the aerial; open the circuits to the transformer and rotary gap. It should be extremely well insulated; capable of quick and easy operation, and the current carrying parts should be capable of carrying the antenna current without loss.

The Receiving Station

A long wave regenerative vacuum tube receiver fitted with mica diaphragm telephones and a tubular or other type of bulb should be used. If the set is built into a cabinet, dust can be kept away from the instruments and both the appearance and efficiency improved thereby. Any regenerative connection is good if constructed in accordance with fundamental principles. In place of loading coils for long wave lengths, I have successfully employed condenser units connected across the primary so that one or more may be cut into the circuit. They are just as efficient under some conditions as the loading inductance and take up far less room. A good storage battery should be used to light the filament, because they are more economical in the long run than dry cells.

Every amateur should own a short wave regenerative set as the range is greatly increased when receiving short wave amateur stations. Any of the several types being sold under various trade names may be employed to advantage.

With the above described apparatus the station will be very near present-day amateur perfection.

J. E. Law, Jr., *West Virginia.*

Second Prize—The Ideal Amateur Wireless Station After the War

I SHALL discuss this subject on the basis that the amateur station will be permitted to operate as before the war, i.e., one kw. power input on the two hundred meter wave.

The first and most important part of any wireless station using a short wave, is the aerial. The ideal station should have the aerial supported by a mast at least seventy feet high, if the aerial is near any buildings, trees or wires. Iron pipe masts, wooden towers, or structural steel towers may be used. A very serviceable and satisfactory mast may be constructed of common iron pipe, which may be purchased at any hardware store. By the use of reducing couplings heights up to ninety feet can easily be secured. Some masts over one hundred feet in height have been made, but require a very extensive system of guying and are not easily constructed. Another method is to use wooden 4 by 4's. The transmitting aerial should be seventy-five feet long, and the long wave length receiving aerial two hundred and fifty feet long. The former should be composed of six wires placed three feet apart. The "L" type is preferred. The longer aerial should have at least two wires spaced four feet apart.

The lead-in from the aerials should be composed of the same size wire as the aerials, preferably stranded phosphor-bronze. It should be supported at only one point between the aerial and oscillation transformer. The insulation throughout the aerials should be Electrose insulators. The lead-in may be brought through the wall in a Marconi deck insulator.

The instruments should be five feet or less from the ground connection, which may consist of buried plates, either tin or copper, buried wires or netting, or iron pipes driven in the earth in the form of a circle. In any case the connections should be well soldered. The underground part of the earth plate should extend under the horizontal part of the aerial. The aerial connection should be made directly to the oscillation transformer, the antenna switch breaking only the earth connection.

The oscillation transformer should be made of heavy brass or copper ribbon. The primary should have three turns eleven inches in diameter and the secondary five turns of the same diameter. The transmitting condenser should be made of one-quarter inch plate glass. The plates should be built in a frame and spaced one-quarter inch apart. They should be coated with heavy tin foil, the whole to be immersed in oil. Copper coated Leyden jars may be substituted. A series multiple connection must be employed for potentials above 15,000 volts.

The spark gap may be a rotary, quenched air cooled, or stationary quenched air cooled gap. An efficient non-synchronous rotary gap may be substituted. The transformer should be of the well known ½ to 1 k.w. closed core type. All connections in the closed oscillation circuit should be made of heavy copper or brass ribbon. The key should have heavy silver contacts and a long arm.

The power lines should be protected by micrometer gaps and condensers. Choke coils may be used between the secondary circuit of the transformer, and the condenser. The aerial or antenna switch may be any of the types offered by manufacturers. A marble base is preferred. In selecting a switch the accessibility and efficiency should be considered.

The receiving set should have three

separate tuning transformers. The first for waves from 180 to 600 meters, the second for waves from 600 to 3,000 meters, and the third for waves from 3,000 up to about 15,000 meters. The first should be used in connection with a regenerative circuit. The second is preferably the so-called Navy type, having all variations of inductance made with switches. One turn variation of the primary and ten turns variation of the secondary should be provided for. The secondary should be shunted with a variable condenser. The third transformer is similar to the second, and larger. If large enough only a primary loading inductance is needed, however, very good results may be secured by the use of both "wing" and "grid" inductances with a smaller transformer. All three sets should be used in connection with a good vacuum tube. Any of the types offered are good, although some are more sensitive than others.

The three transformers are used for reception from amateurs and boats, medium long wave spark and arc sets, and long wave arc and spark stations respectively.

In the above specifications a few things have been omitted for separate discussion. The location of the instruments is a very important item for efficient operation. If possible an operating hut should be constructed so as to place the instruments directly under the aerial. This allows short connections which are important. A good hut can easily be constructed by any live amateur.

Another thing to be taken into consideration in the ideal station is the matter of connections. Many different circuits especially for the receiving set have been published. Before making permanent connections different circuits should be tried. Although one gets good results it may be possible to still further improve on them. This applies especially to the long wave receivers.

The transmitter circuit is not susceptible to various connections. The secondary of the transformer is connected in multiple with the condenser, the gap and primary of the oscillation transformer being in series with the condenser.

An important after the war consideration will be the use of undamped wave sets. However, no details can be furnished at the present time.

The operation of amateur stations, after reopening, promises to be a more dignified proposition than at the time of closing. There will be fewer of the old spark coil "jammers" and only the ones who really mean business will open their stations. Also the fellows who enlisted for Government training will be better operators and consequently erect better stations upon returning. Indeed what we have all wished for is about to take place. Ideal conditions as well as ideal stations will prevail.

JAS. B. HOLSTON, *Illinois.*

Third Prize—Ideal Specifications for a Spark Station

MY ideas regarding the ideal radio set may prove of interest to the general type of radio amateur. All component parts of the transmitting set are mounted separately on a suitable sized table—taking particular care to so arrange the apparatus that the leads in the oscillatory circuit are as short as possible.

The condenser is the usual bugbear in the transmitter. It will be given further consideration. The solution of the condenser problem in my opinion is to make it an oil immersed affair—using a good grade of transformer oil. If automobile windshield plate glass of ¼ inch thickness is used, little trouble will be experienced as far as "puncturing" of the plates is concerned. Twelve 10" x 14" plates in parallel give the correct capacity for 200 meter operation. Tinfoil 8" x 12" should be "pasted" onto the glass by putting a few drops of transformer oil on the plates and placing the tinfoil on and squeezing the oil over the surface of the plates with a photographic roller. Then solder copper ribbon at least ½" wide to the tinfoil.

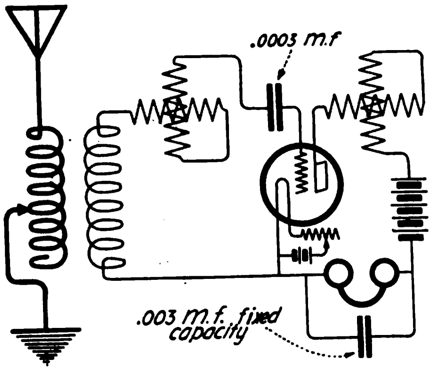

Diagram of the Armstrong circuit for wireless receiving set

After each of the 12 plates have been coated they are stacked together and bound with canvas strip. A suitable containing tank should be next obtained. It should be large enough to allow at least one inch clearance around all the edges of the glass plates. Wood strips one inch thick should be placed on the bottom of the tank to keep the plates insulated from it. A bakelite or hard rubber tap should be cut to cover the tank and keep out all dust and moisture.

The rotary gap is the next item. A bakelite disc 10 inches in diameter should be obtained. The thickness should be ⅛", no more is necessary, and is really harmful, since the lighter

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the disc the less the amount of power necessary to turn it. Next 10 brass electrodes are constructed from ¼" threaded brass rod. They should be one inch long, each end finished in a chisel shape with an edge ⅛" thick. Eight of these electrodes should be mounted on the periphery of the disc so that they protrude equally on both sides of the disc and should be held in place by means of a nut on each side of the disc. The stationary electrodes are mounted on brass standards on a marble or bakelite base, one electrode on each side of the disc. The disc itself should be mounted on a polishing lathe, similar to a small jewelers' lathe, which can be bought at any hardware store for the amount of $2.50. I much prefer a belt arrangement such as this type of mounting requires, to the usual method of mounting the disc directly onto the shaft of the motor. One reason is that it allows the speed of the rotor to be more easily changed than the type driven by an induction motor, and another reason is the elimination of the danger of high potentials burning out the winding of the motor. A fan motor or any motor of 1/16 h.p. is entirely suitable for running this gap.

The oscillation transformer is made of 1½ inch brass strip employing the pancake type of winding. The primary is made of 4 turns, the outside diameter of the first turn being 8 inches. The turns should be at least ½ inch apart. The secondary contains 10 turns of similar size. Both primary and secondary are mounted on bakelite strips. The secondary is mounted on a hinge to vary the coupling. Very heavy helix clips should be used.

Any standard make transformer with a secondary potential of at least 15,000 volts is suitable. The Thordarson, 1 kw. 20,000 volt model seems to be the favorite and from a point of efficiency, reliability and cheapness it is the best on the market, in my opinion.

The connections from the secondary to the condenser should be made of, say, No. 24 magnet wire. Two choke coils of No. 24 wire on tubes 2 inches in diameter and 3 inches long are sufficient to take care of all "kick backs" from the condenser.

All connections in the oscillatory circuit should be of very heavy copper sheeting. I buy copper sheet 1/32 inch thick and 6 inches wide in lengths of 2 feet and cut this to the required length with a width of 1½ inches. If all connections in the oscillatory circuit are made as short as possible and the set is tuned by means of a hot wire ammeter and wave meter, no one should experience any great difficulty in working 1,000 miles during the favorable season, provided a modern type of regenerative set is used at the receiver.

RECEIVING SET

If one cannot afford to buy one of the popular makes of regenerative sets on the market the solution is to construct one. Whether it be mounted in a cabinet or not is optional with the constructor. Personally I prefer to leave mine unmounted so that I can readily adapt the circuit to the various changes that are necessary in order to keep abreast with the times.

The primary of the receiving transformer is 3 inches in diameter wound with 50 turns of No. 24 S.S.C. magnet wire with switches for single turn variation of inductance. The secondary is 2½ inches in diameter, wound for one inch with No. 31 S.S.C., no taps are taken off secondary. The necessary changes of inductance are obtained by using a variometer in series with the secondary. A suitable variometer is described in "How to Conduct a Radio Club." Another variometer of similar size is required in the plate circuit. The diagram of connections is enclosed which is the Armstrong circuit. Brandes Superior telephones fill the bill very satisfactorily.

The aerial should be as high as possible and not over 100 feet long unless it is made of the "T" type, in which case it can be 120 feet long.

The ground connection should be attached to water or gas mains and also to a 4 wire counterpoise buried under the ground for a few inches, parallel and underneath the aerial.

With a transmitting set of the above description, I regularly "put" 8.5 amperes into an aerial 80 feet long and 40 feet high and have as my transmitting record a distance of 1,600 miles.

My receiving record is 1,800 miles with a receiving set similar to the one described having copied 6 EA at Los Angeles, Cal., at Little Rock, Ark., six consecutive nights during the latter part of the 1917 season.

JOHN M. CLAYTON, *Arkansas.*

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Queries Answered

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Positively no Questions Answered by Mail.

I. H. W., Fire Island, N. Y., writes:

In your December issue I notice an article mentioning that the German station at Nauen, (POZ) could only be heard with a long wave undamped receiver. Nauen now employs a damped transmitter operating at six thousand meters which during the war was used both for sending instructions to submarines and for transmitting press and time signals.

I have copied this station (POZ) on the Marconi type 106 receiver with carborundum detector, without any extra loading coils, up to one thousand miles.

* * *

E. B. L., Sergeant Signal Corps, U. S. Army, writes:

Referring to a brief descriptive item on the Nauen, Germany (POZ), radio installation, printed in the October issue of your valued publication; it may be of interest to you to know that I have been copying matter transmitted from that station, day and night, at all points of our Alaskan itinerary. Their signals are powerful and I copy them with a typewriter, without difficulty. In addition to considering the great distances, a relief map of Alaska will show unusual ore-bearing mountainous obstacles, which, however, appear to affect in no way the amplitude of signals of long wavelengths. We intercept press matter enroute from Eastern United States, Naval Stations to European stations.

* * *

C. V. H., Kingsley, Kans.:

Ques.(1)—Does it make any difference in which direction the turns on the primary and secondary coils of a receiving tuner are wound?

Ans. (1)—It makes no difference.

* * *

G. S., Gary, Ind.:

Replying to the questions in your recent communication: We would not recommend the use of a 25-cycle alternating current for amateur purposes as the spark frequency will be so low that it will be difficult to read your signals. By the use of a non-synchronous rotary spark gap the spark frequency could be improved, but still the note would partake of the characteristic of the 25-cycle current. The inductance of a high voltage transformer primary constructed for 60-cycles is too low for use at 25-cycles. You could best be informed on the rewinding of this particular transformer by communicating with the manufacturer.

* * *

H. S., Jenks, Okla.:

When the expression "resonance between generator and transformer" in radiotelegraphy is spoken of, reference is made to resonance between the complete transformer and its secondary condenser with the frequency of the alternator. Owing to the close coupling between the primary and secondary coils any change of capacity across the secondary will tune the complete circuit from the alternator through the transformer. An article by H. E. Hallborg in a past issue of the Proceedings of the Institute of Radio Engineers will give you more information on this particular point.

* * *

A. D., Manchester, N. H.:

The natural wave of your "T" type aerial, 120 feet in length and 50 feet in height, is close to 200 meters and with the receiving transformer you have mentioned, the complete system will respond to wave lengths to 4,000 meters.

Keep in mind that the ban on amateur communications has not yet been lifted, but we may expect the removal of these restrictions at an early date.

* * *

S. M. G., Hampton, Conn.:

You may expect in a forthcoming issue of THE WIRELESS AGE complete instructions and working drawings for the design of long distance vacuum tube receiving sets. For a two-stage amplifier, we would suggest that the first tube be connected up with a regenerative coupler for the amplification of radio frequencies. The grid circuit of the second bulb should be connected to the plate circuit of the first bulb by an audio frequency transformer with or without iron core. The loading coil described on page 515 of the April, 1917, issue of THE WIRELESS AGE is applicable for this work. No large gain in efficiency, however, is obtained by the use of multi-layered coils. It is possible to design a receiving set for a range of wave lengths from 5,000 to 12,000 meters wherein the entire range of wave lengths is secured by variation of the variable condensers alone. If you will give us a more complete description of just what type of apparatus you contemplate building, we could give you more definite advice.

If multi-layered coils are employed in receiving circuits, we would advise that the inductance be varied by a multi-point switch. We do not recommend the construction of a universal receiving set to cover wave lengths from 200 to 10,000 meters as it complicates the equipment on account of the necessity for eliminating the unused turns when operating on the shorter range of wave lengths. It would perhaps be simpler to construct two receiving tuners, one for lower range of wave lengths and the other for the higher range.

The method you suggest in question No. 3 for varying the inductance of coils is feasible, but not entirely necessary. You can rest assured that vacuum tubes will be supplied to the amateur market when the ban is lifted.

* * *

W. E. H., Auburndale, N. Y.:

The loading coil to accompany the apparatus described on page 82 in an early edition of "How to Conduct a Radio Club" may be 5½ inches in diameter, 28 to 30 inches in length, wound with No. 22 or 24 S.S.C. wire. If this proves insufficient to attain the wave length of 10,000 meters a small variable condenser may be connected in shunt to the primary winding of your transformer. Regarding the taps on the coils L-2 and L-7: A very wide range of wave lengths may be attained simply by employing a fixed number of turns, the wave length being changed by variable condensers.

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Under certain conditions, it may be of advantage to bring taps from the coil. Satisfactory closeness of adjustment can be secured by tapping these coils every two or three inches. The books "How to Conduct a Radio Club" and "Practical Wireless Telegraphy" give numerous diagrams for connecting up transmitting apparatus. A fundamental circuit, for example, appears on page 98 of "Practical Wireless Telegraphy." Use this diagram of connections beginning at the notation marked "generator." You perhaps will not employ the wattmeter or reactance coil shown in the diagram. In the third revised edition of "How to Conduct a Radio Club" on page 39, figure 17 is shown a diagram giving the fundamental amateur circuit. The amateur transmitter you will observe is very simple.

* * *

L. R. D., Kinsale, Va., inquires:

Ques. (1)—Which would be the better aerial for all around receiving work, one consisting of two wires, 200 feet long and 40 feet in height, spaced 6 feet apart; or one 100 feet in length 40 feet in height using 4 wires, spaced 3 feet apart?

Ans. (1)—The smaller aerial would be better for amateur reception, but for long waves either aerial would be suitable. As a matter of fact, considering modern types of vacuum tube receivers, the dimensions of the aerial have little to do with range of reception provided the fundamental wave length of the antenna is not too great to establish resonance with the distant transmitting station. No matter how weak the intensity of the incoming signals, by cascade audio or cascade radio frequency amplification, they can be enormously amplified and brought to audibility.

Ques. (2)—What would be the approximate wave length of this aerial?

Ans. (2)—The 200-foot aerial has, approximately, a natural wave length of 335 meters and the 100-foot aerial approximately 165 meters.

Ques. (3)—Please advise the correct hook-up for the attached diagram of connections for galena and silicon crystal detectors.

Ans. (3)—Much better response can be received from distant transmitting stations by shunting the head telephone around the fixed condenser which in your diagram is marked "FC." Otherwise the diagram is correct.

* * *

H. S., Jenks, Okla., inquires:

Ques. (1)—What type arc transmitter does Nauen, Germany employ?

Ans. (1)—We have no knowledge that an arc transmitter is in use at this station. We understand that it is equipped with an 8,000 cycle alternator, the frequency of which is increased to 16,000 by a set of frequency changers. The Nauen station is also equipped with spark apparatus but we have no information regarding the power or the design of the set.

Ques. (2)—How does the von Lepel type of transmitter compare with the ordinary spark system in respect to range and efficiency?

Ans. (2)—We have no definite data on the efficiency and range of this apparatus as compared with other systems. Ship sets have a transmitting range of about 300 miles. Only a very few installations of the von Lepel system have been made.

Ques. (3)—Where can I obtain data on the construction, operation and efficiency of the von Lepel ½ kw. set?

Ans. (3)—A brief description of the Lepel system is given on page 688 of the third edition of the "Principles of Electric Wave Telegraphy and Telephony," by J. A. Fleming. Page 193 of the second edition of Dr. Eccles "Hand Book of Wireless Telegraphy and Telephony" gives some details regarding the system. The only important feature regarding the design of the Lepel transmitters is the arc gap which is sometimes called a quenched arc. It is described briefly in Fleming's text above mentioned.

The von Lepel discharger produces damped oscillations at rates above audibility and hence for telephonic reception these oscillations must be modified to an audio frequency. This is usually effected by shunting the arc with an audio frequency circuit as well as the usual radio frequency circuit, which causes the arc to oscillate at a radio and audio frequency simultaneously when the key is closed. In this way groups of damped oscillations are induced in the antenna circuit. If you will refer to pages 212, 213, 214 and 215 of the "Hand Book of Wireless Telegraphy" by James Erskine-Murray, you will obtain further details regarding the Lepel system.

* * *

Corp. G. M., Fort Sill, Okla.:

Ques. (1)—Can an arc transmitter be operated from a 110-volt 60-cycle current? If so, please give connections of the apparatus.

Ans. (1)—An arc set operated by alternating current would produce damped oscillations and is inefficient. However, it is possible to use alternating current in a semi-arc system such as is described on pages 68 and 69 of Dr. Goldsmith's "Radio Telephony."

Ques. (2)—Why is it that an induction coil will not operate on 110 volts even when there is an incandescent light in series with the primary winding?

Ans. (2)—The inductance of the primary winding of the induction coil may be too low or too high for use with alternating current. The design for an induction coil for interrupted direct current is distinctly different than for an open core alternating current transformer. Now and then one comes across an induction coil which may be used on either alternating or direct current provided a series resistance or a series reactance is employed to regulate the primary current.

With an incandescent light in series with the primary winding of your induction coil the flow of current is governed by lamp, and if the lamp passes but ½ ampere, the primary current is too low to produce an appreciable effect on the secondary.

* * *

A. R., Scottsville, Mich.:

It is considered the better procedure to "bunch" the lead-in wires beginning a few feet from the flat-top portion of the antenna down to the lead-in insulator in the wireless cabin.

The international signal PRB is an intimation to the receiving operator on the part of the transmitting operator that he will use the International code of flag signals in his radiograms. These, of course, are transmitted by radio and not by flags.

The sales price of vacuum tube transmitters can be obtained from the Commercial Department of the Marconi Wireless Telegraph Co. of America, 233 Broadway, New York City. Either alternating or direct current may be employed in connection with the transmitting tube. If alternating current is used it must be rectified for the plate circuit. Alternating current may be used to light the filament. The voltage of the filament battery may vary from 6 to 110 volts and the plate voltage from 150 to 8,000 volts, according to the design of the tube.

Radio Telegraph and Telephone Signal System

A WIRELESS telegraph and telephone system described by August J. Kloneck is shown in the accompanying drawing, figure 1. In the diagram the numeral I is a source of alternating current which furnishes power for the motor generator 2, the motors 3 and 4 of the high frequency generator 5 and the motors 6 and 7 of the rotary spark gap 8.

In operation, current from the generator 2 flows through the wire 10 to the receptacle 11 of a transmitter valve 9 which contains a suitable liquid such as mercury. An electrical circuit is completed through the opening 12, with the mercury of receptacle 13, through the opening 14 of the auxiliary receptacle and the port 16 of slide valve 15. The valve is rigidly secured to the disc 17, which is in reality the diaphragm of a telephone transmitter. Variations of the diaphragm as usual cause a varying speech current to flow through the transmitter and thereby varies the field current of the high frequency alternator 5.

The field of the generator 46 and the armature 47 are attached to shafts 25 and 27 of the motors 3 and 4, which can be substituted by high speed turbines. They are rotated oppositely, producing current of very high frequency.

The frequency of the current is further increased through the special rotary spark gap shown at 8, which works on the vernier principle. For example, if the disc 22 has 9 points and the disc 23, 11 points, then the frequency of the current for one revolution will be 9 x 11. This arrangement permits any desired number of oscillations by varying the number of spark points upon each disc.

The current from the armature of the alternator flows through collector rings 25 and 26 which are attached upon the shaft 27. Brushes 28 and 29 serve to conduct the current from the rings to the terminals of the generator. One terminal is connected through wire 32 to a conductor ring 33 and disc 22, through the spark gap to the disc 23 and ring 34, and through wire 35 to the coil 36 of a spark gap transformer. The current from the second terminal of the generator 5 flows directly to the coil 37 of the spark gap transformer. As will be seen in the illustration, each terminal of the generator 5 is connected with a coil of the spark gap transformer, or the coils 36 and 37, respectively.

It is convenient to have one disc movable in respect to the other in order that the spark distance may be varied. For the purpose of preventing the development of higher voltages an adjustable spark gap 39 shunted across oscillation transformer is provided.

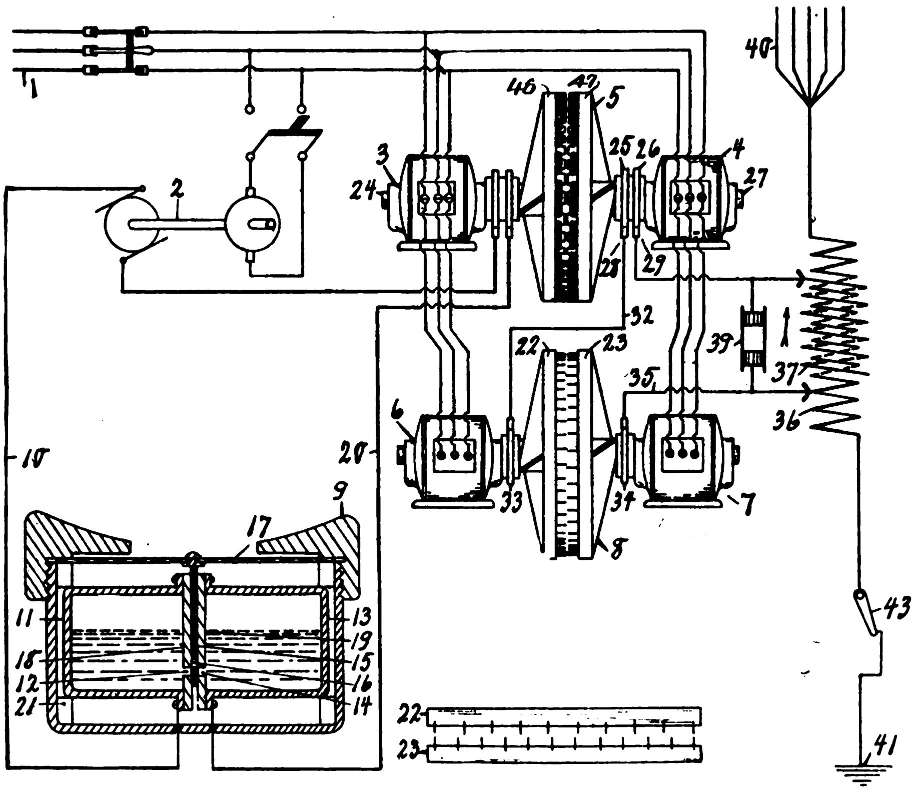

Figure 1.—Plan of construction and diagram of connections of the radio signaling system.

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The Attack on the Alexander Bill

(*Continued from Page 30.*)

Paul F. Godley appeared for the amateur on the last day of the hearing. He stated that he represented the Radio Club of America and that in executive session its Board of Directors originally concluded that the amateurs would be satisfactorily and sufficiently represented by Mr. Maxim. But developments since then had made it appear advantageous to clear the atmosphere as it concerned the radio amateur. "The Radio Club of America wishes to go on record as firmly opposed to the bill now before this committee," stated Mr. Godley.

He gave as a reason for this decision, that regulation under the present law and the Department of Commerce had been entirely satisfactory to both amateur and commercial interests, and fair to these and the Navy.

A decidedly greater sense of security would be felt by the amateur under the Department of Commerce, was Mr. Godley's conclusion, because experience has shown "that that department can and does give him a square deal," the amateur's representations being given consideration on an equality basis with those of commercial and governmental stations.

Mr. Godley then asked the congressmen to consider the subject from the standpoint of the inventor. "Whether he knows it or not, every serious amateur is potentially and at heart an inventor," he asserted. "As an inventor, it is decidedly to his interest to do everything in his power to prevent the monopoly of radio by the Navy.

In conclusion, Mr. Godley offered in the name of his club certain recommendations, "should this bill, against the wishes of the amateur, be passed in any form." These were, briefly, a license requirement of 60 letters per minute; receiving stations, but not their operators to be licensed; a general restriction to 250 meters, except in special cases, and no geographical limitation on power excepting within 5 miles of a naval receiving station; that power restrictions remain as defined by the law of 1912, pending a national conference of amateur radio organizations to determine a policy.

In a rebuttal statement, Captain Todd, Director of Naval Communication, said that the hearings had apparently demonstrated how difficult it would be for amateurs to agree among themselves, attempts to get together, he had been told, meeting with very poor success.

Congressman Green took exception to this statement. He illuminated the difficulties of the few present to undertake agreement for the large number who did not come to Washington. But, even so, no great lack of unanimity or agreement appeared in the conversations he had held. "They were largely against it," he stated, "and some of them very fiercely against it." Those who had not been satisfied with explanations of the bill and amendments had said, "that they could not undertake to subscribe to an agreement without conferring with some of the vast number of men engaged in the radio art; it would have been ridiculous for them to have undertaken to bind other people without conferring with them."

Captain Todd said that his point was, it was just as well that the Navy did not try in the beginning to incorporate in the bill anything that would please the entire number of amateurs. "From the earnestness with which the amateurs talked," he added, "I think it probable that you (the Congressional Committee) will pay considerable attention to them."

The hearings closed a few minutes later, at 6 p. m. of December 19. On January 16, by unanimous vote, the committee laid the bill on the table, without a dissenting vote on the resolution to that effect offered by Congressman Bankhead of Alabama.

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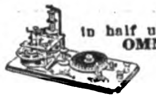

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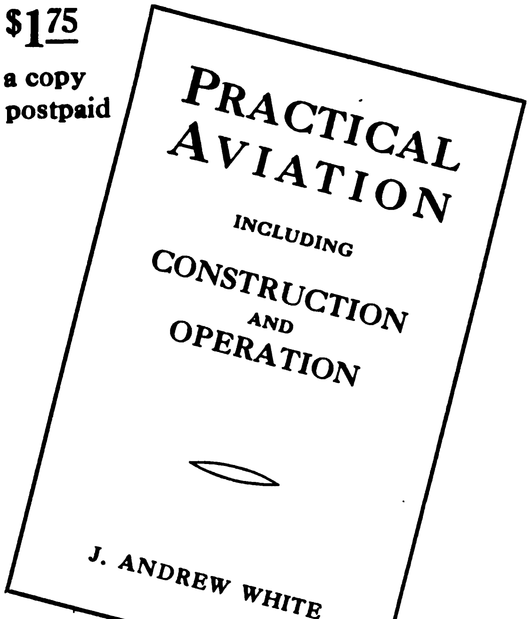

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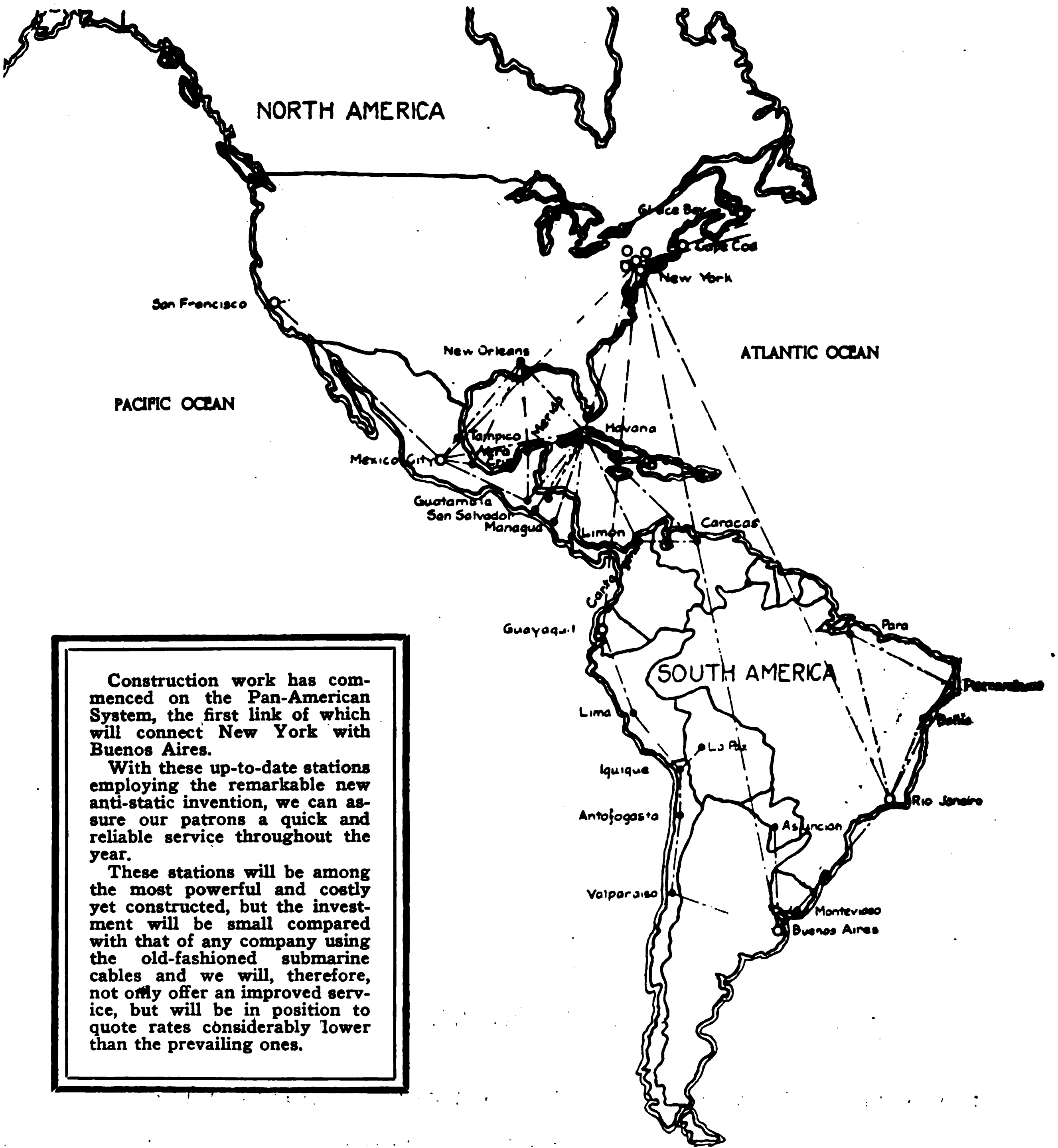

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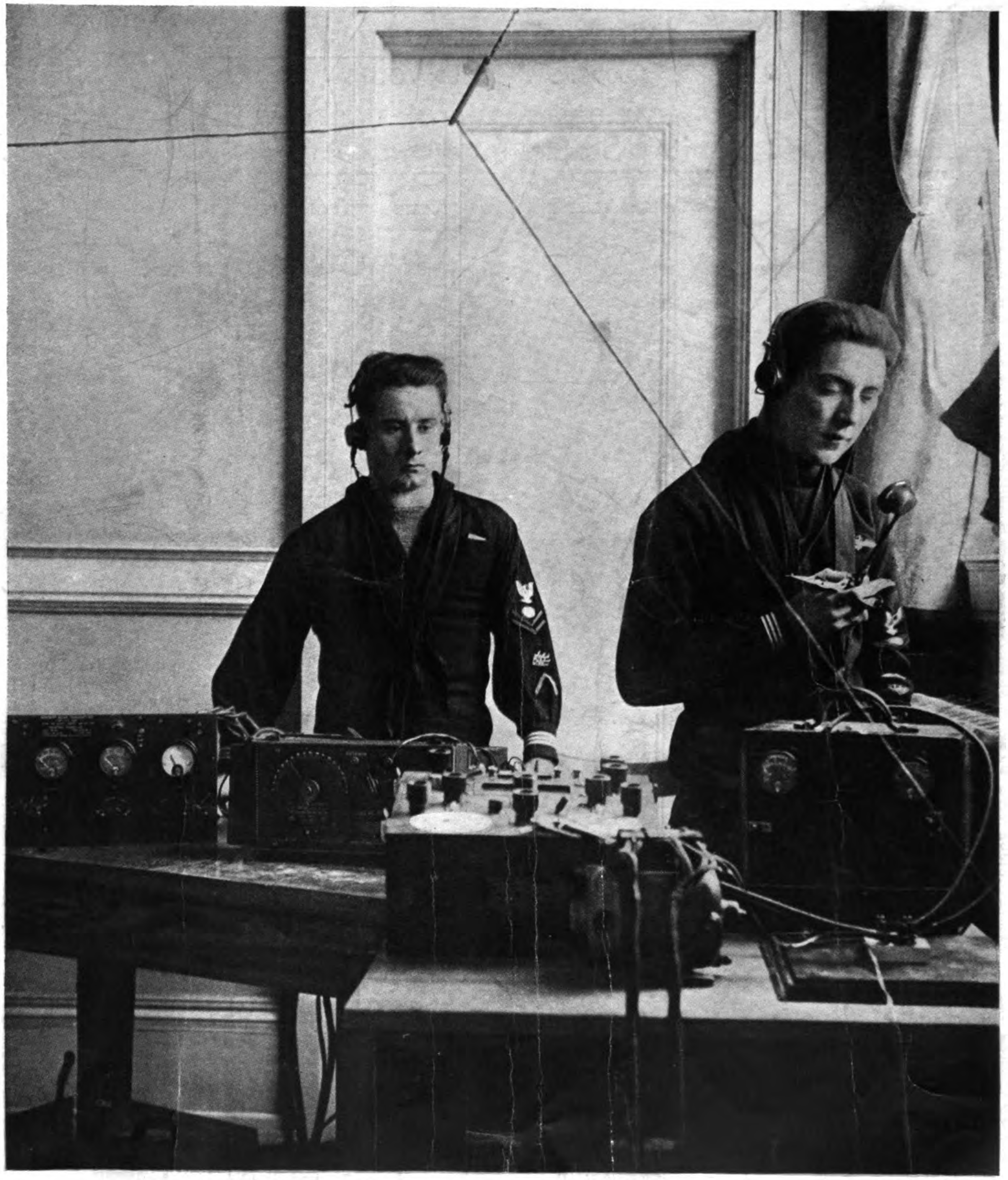

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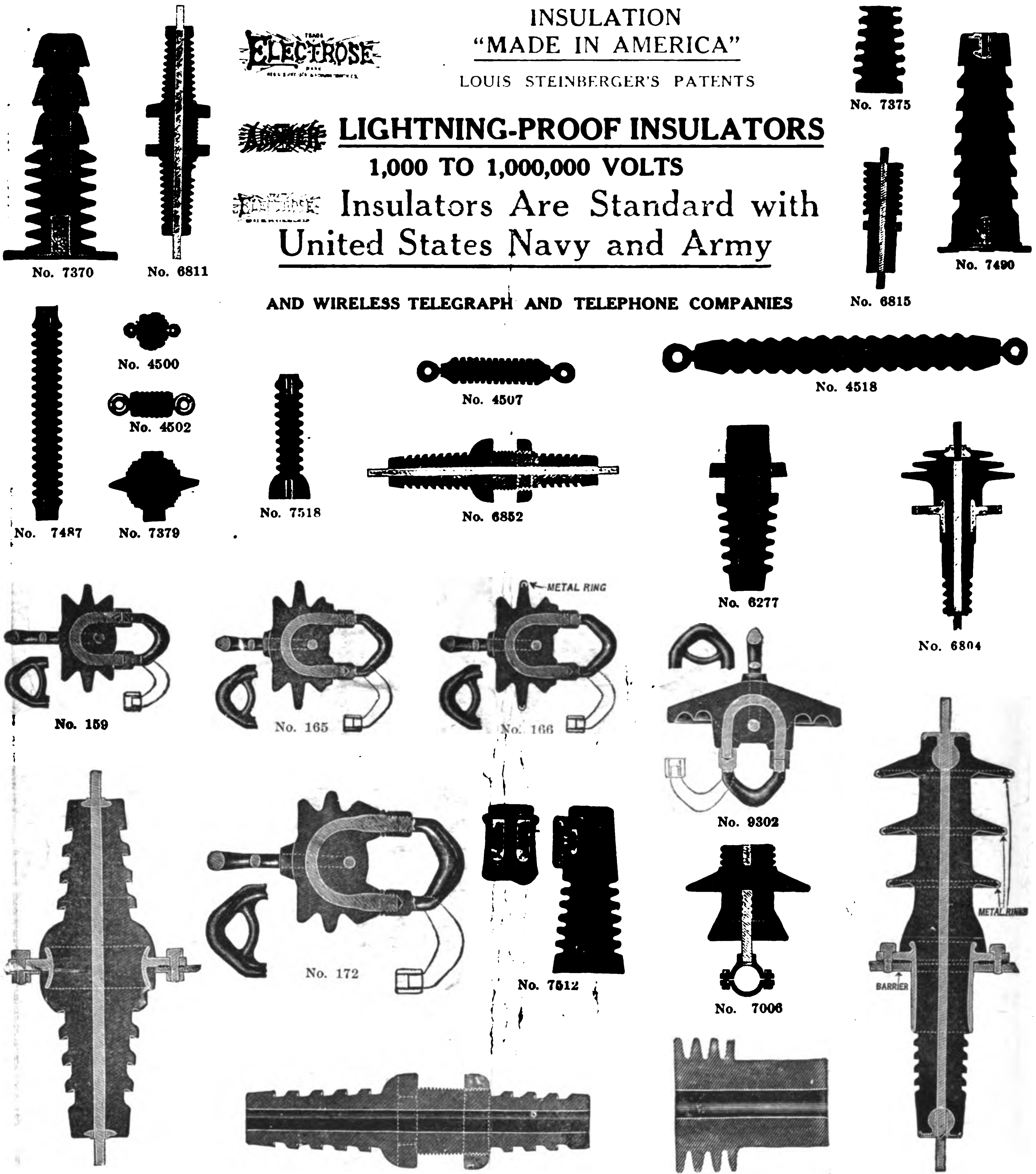

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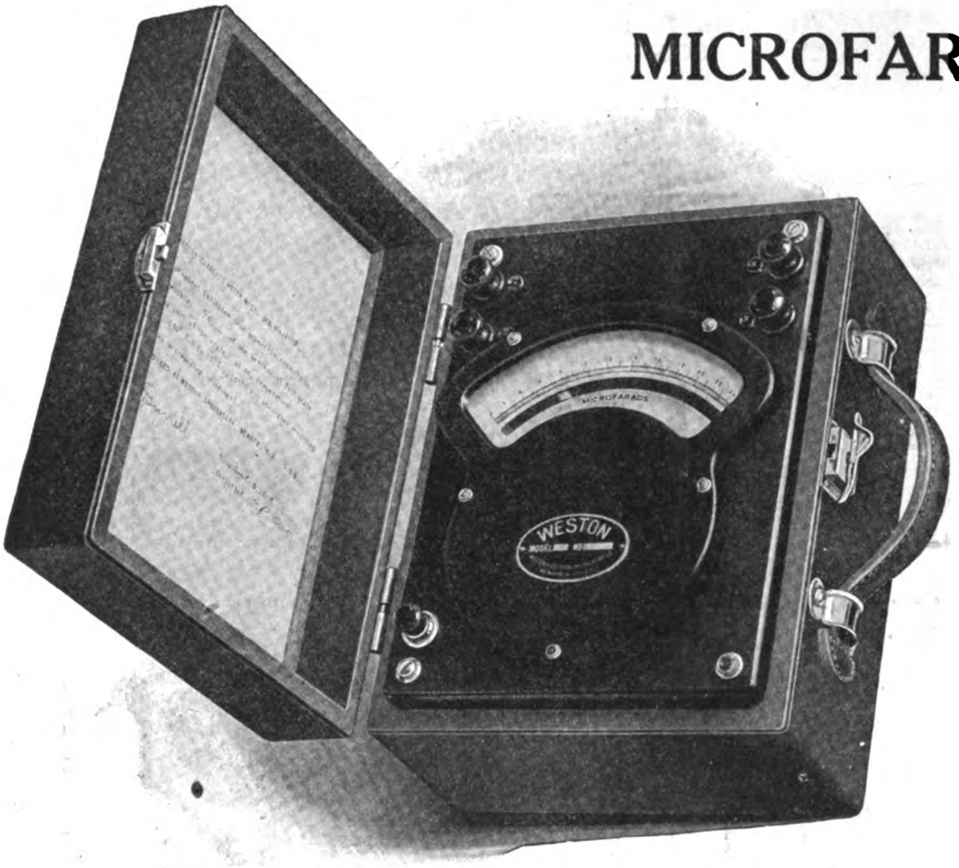

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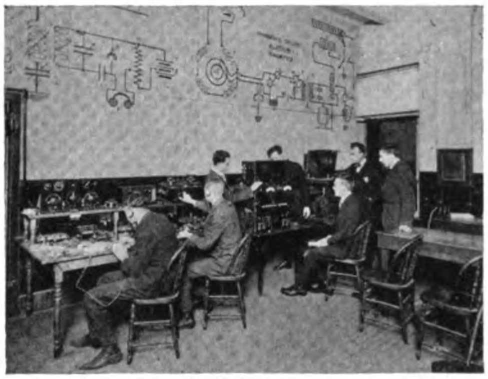
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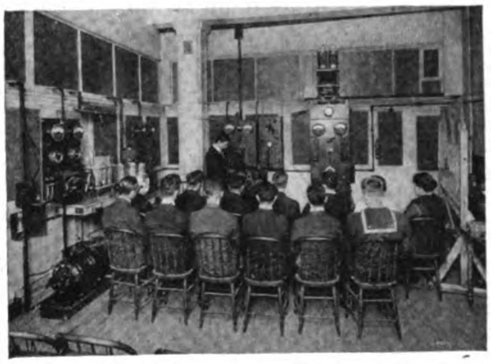
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The Wireless Age

Edited by J. ANDREW WHITE
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Vol. 6

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Third Cover

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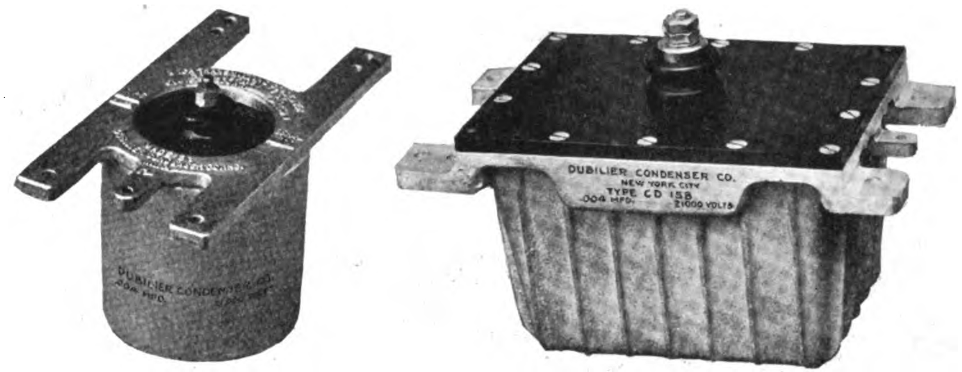

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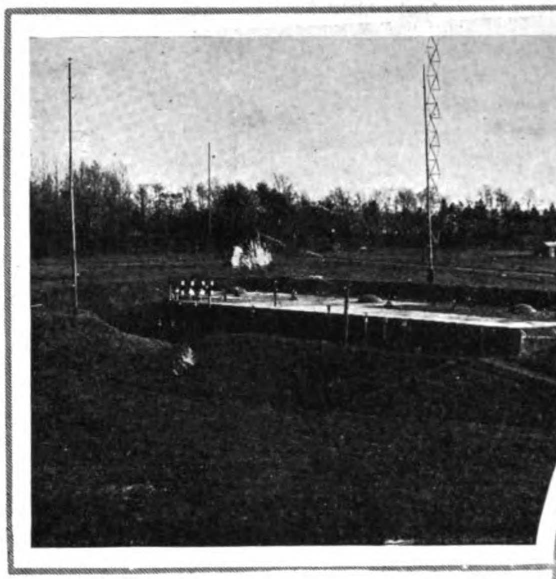
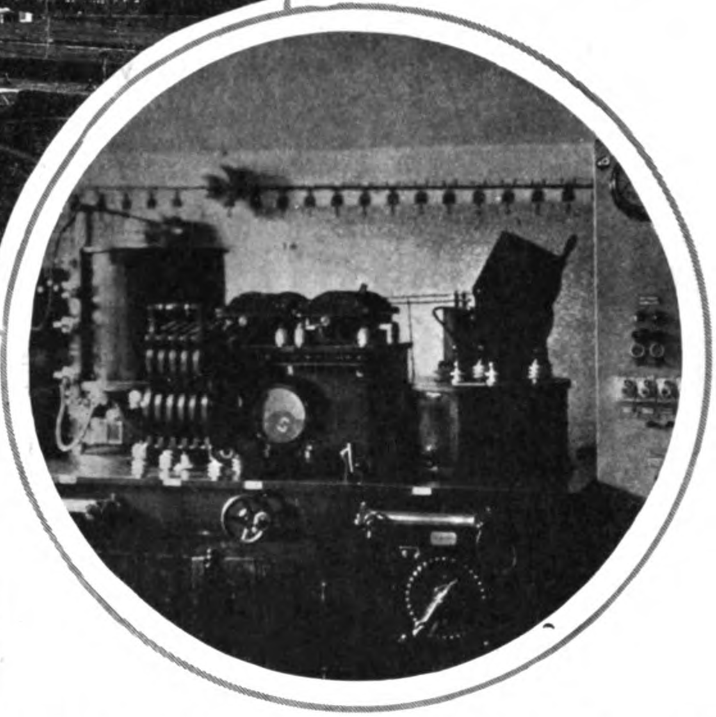
French Official Photos

Metz

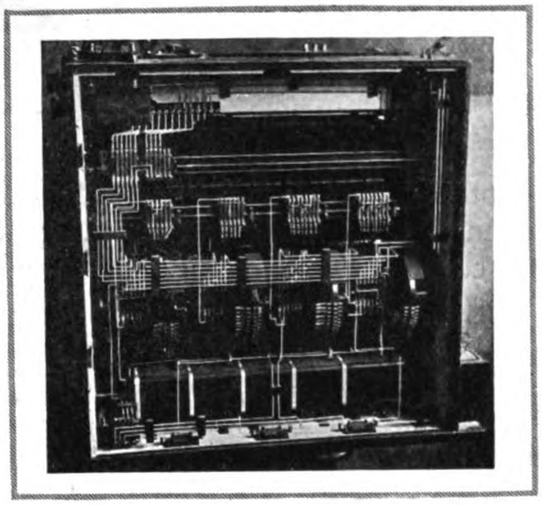
Taken from the Hun



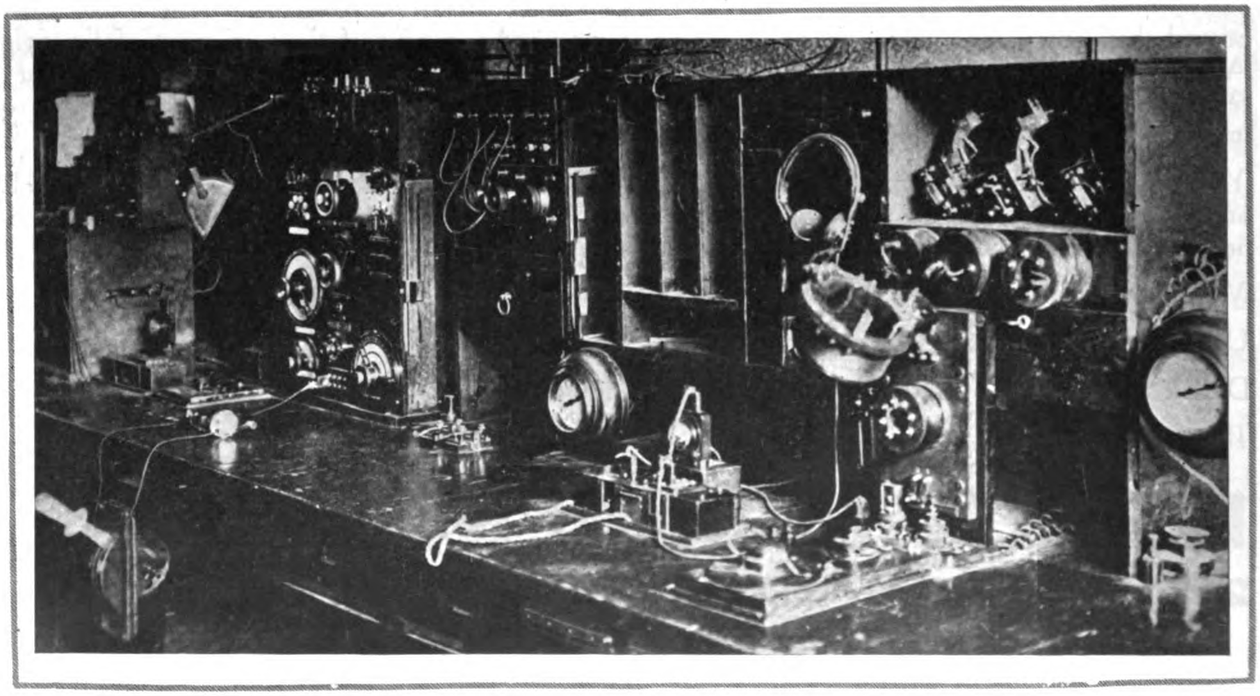
To the left, a general view of the powerful wireless station maintained underground at the stronghold at Metz, delivered to the Allies under the armistice terms



Above, in circle, the transmitting apparatus which was hooked up to the antenna on the 85-meter tower shown in the upper view



To the left, the receiving tuner with the front cover removed, revealing the elaborate mechanism for changing to the numerous wave lengths used for secrecy in transmission



The operating table with a typically German multiplicity of tuning appliances

VOL. 6. No. 6. MARCH, 1919

THE WIRELESS AGE

WORLD WIDE WIRELESS

Blimp Flying Over N. Y. Directed by Wireless Phone

A DEMONSTRATION in directing aircraft by radio telephone was given on January 17th from the roof of the Equitable Building, New York. It was arranged by the navy as a feature of the opening of the $2,000,000,000 War Savings Stamp campaign. The radio communication was between a group of men on the roof of the Equitable Building and Navy Dirigible A242, escorted by a formation of airplanes from the Rockaway Station. The airship, commanded by Ensign John Benridge, cruised over the city for about half an hour, following the directions given by wireless telephone. The weather was thick and the machines appeared at an altitude of about 1,000 feet.

James S. Alexander, President of the National Bank of Commerce, was the first of the civilians present to communicate with the airship. He got into touch with Ensign Bark, the radio man on the dirigible, after the navy operators had made the necessary adjustments. At that time the weather was so thick that the aircraft could not be seen. Mr. Alexander inquired when they would come into sight, and almost while he was talking the formation came through the mist.

"You will circle about the Woolworth Building," directed Mr. Alexander. The Blimp almost immediately changed her course, and headed to execute the order. This accomplished it carried out other spoken orders from the group on the housetop. Mr. Alexander said Ensign Bark's brief replies had been quite distinct. He had requested the Ensign to speak slowly and distinctly, and when this was done he heard every word clearly.

Others who conversed with the operator on the airship as it circled over the lower part of the city were George T. Wilson, Major General Thomas H. Barry, Major General Davis C. Shanks, Guy Emerson, Vernon Munroe and A. M. Anderson.

New Stations for Mexico and Nicaragua

A DAILY NEWSPAPER of Managua states that a Mexican gunboat is soon expected to arrive at Corinto with material for the installation of a wireless telegraph station presented by the Government of Mexico to that of Nicaragua. The wireless station is to be of the same power as the one given by the Government of Mexico to the Government of Salvador. The same vessel will also bring the Charge d'Affaires of the Mexican Government, near the Government of Nicaragua. With the members of the Mexican legation in Nicaragua is a detachment of Mexican marines who will accompany the party into the interior for the purpose of presenting to the President the wireless station referred to.

It is further stated that in Mexico a wireless telegraph station was recently established at Pungarabato, State of Guerrero, powerful enough to communicate with the stations at Chapultepec, Acapulco, and other distant points of the Republic.

British Marconi Company Declares Dividends

THE directors of Marconi's Wireless Telegraph Co., Ltd. (British corporation) have decided to pay a dividend of 7 per cent, less income tax, on the preference shares and a dividend of 5 per cent, less income tax, on the ordinary shares, both dividends on account of the year ended December 31 last.

Photo Paul Thompson

Radio telephone test in New York consisting of the direction of aircraft, conducted by Major General D. C. Shanks and General Thomas Barry

Navy Protests Tuckerton Tax Value

THE United States Navy, which has control of the Tuckerton Radio Station, has appealed from the assessment of $400,000 on the property, fixed by the County Board of Taxation, and has asked its reduction to $225,000. The board has granted naval officers time to file an inventory.

The station was built by a German company in which the Kaiser was said to be a heavy stockholder. It was subsidized by the German government and exploited at the time as having cost two millions. Conservative investigators concluded that the two millions were marks, which would make the cost $500,000.

The station was seized by the United States in the summer of 1916, and has since been in charge of the Navy Department and is guarded by 500 marines.

Shipping Growth Requires Call Letter Expansion

A CURIOUS illustration of the fact that growth of the American merchant fleet is greater than experts believed would be possible is afforded by inadequacy of the radio call code. The allotment of alphabetical call letters has been upset by additions made to American shipping. To the United States were assigned combinations from KDA to KZZ, all beginning with N and all beginning with W.

The American merchant marine has reached such proportion that supply of calls alloted to the United States has been exhausted, and many four letter calls have been adopted as a makeshift. A commission on interallied radio communication will meet in Paris to consider revisions of the code and other important post-war problems.

The powers of this commission will be limited to recommendations. Radio reform can be accomplished only by a more representative body, the International Radiotelegraphic Conference, which should have met in Washington in 1916, but was prevented by the war.

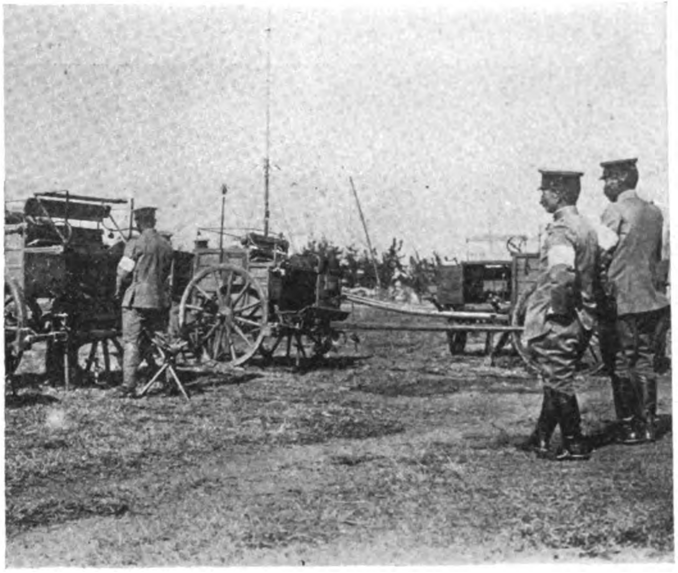


Photo Press Ils. Svce.

Japanese wireless station of the field cart type which shows the similarity with U. S. Army equipments

Distress Call Wirelessed When Fire Puts Out Beacon

A RECENT fire partially destroyed Execution Lighthouse and burned its machinery, leaving the station without power to flash its signal and operate its foghorn. The lighthouse is located between New Rochelle and Sands Point, N. Y., and with the Sound shrouded at night in a heavy fog, several naval craft were sent to patrol in the vicinity and warn vessels of dangerous rocks.

A wireless calling for aid was sent out by Peter Forget, keeper of the lighthouse. It was picked up at Police Headquarters in New York City, and a fireboat was immediately despatched to Forget's assistance. The Navy Department also sent vessels, and four launches filled with soldiers put out from Fort Slocum.

The fire started in a wooden shed and quickly spread to the generating plant. Because of the fog the blaze was not seen from the shore until it was at its height.

It will take several days to install new machinery, and in the meantime the naval craft will remain off Execution Rocks.

New Commercial Wireless Service for Airplanes

FURTHER details of the scheme for supplying Marconi service to airplanes, announced in the February issue, are now at hand. From London, word has been received that Godfrey Isaacs, managing director of Marconi's Wireless Telegraph Co., Ltd., has made public some of the arrangements made in connection with a new organization for the development of air service for passengers, mails, parcels post, and parcels delivery for even larger goods.

The service will commence in the United Kingdom and the Continent, but will later develop to all parts of the world. A measure of safety is going to play an important part in the rapidity with which the services are developed, and it must be apparent that safety will be increased by the assistance of wireless and a thorough and complete organization for its effective use.

The company will be prepared to supply every airplane with a combined wireless and telegraph installation, and to supply with it an efficient and thoroughly qualified operator, adopting the same system as is in force with regard to ships—namely, keeping the apparatus up-to-date, maintaining it in perfect working condition, and supplying the operator at a combined charge rate per annum.

They will issue charts giving the exact position of a number of their stations in all parts of the world, and these will be furnished with direction-finders, which will show to the operator the exact position of the airplane wherever it may be. There will also be charts issued dividing the air into zones, each of which will be numbered. They will at given periods send out air reports and in return will receive air reports. Record charts will be issued from time to time showing these reports, which will serve as comparisons of disturbances in the air, and will furnish valuable information for the guidance of pilots.

Russian Station Connects with France

OMSK, in which are centered the hopes for the re-building of a new Russia, after months of isolation, is now actively in wireless communication with the outside world. Hourly reports, containing a complete news service, are received in Omsk direct from the French wireless station at Lyons, France. Outgoing communication will be inaugurated soon.

The wireless tower which dominates the city is the result of the enterprise of M. Nettenent, a Frenchman, formerly consul in New York. In company with a wireless expert and a number of compatriots Nettenent brought the material on a perilous journey from Archangel across the Kara (Black) Sea to the Gulf of Obi. The material was then brought down the Obi and Irtish rivers to Omsk.

From Omsk to Lyons is 3,000 miles on a direct air line over Bolshevik Russia and Central Europe. Omsk is about midway between the Atlantic and Pacific oceans.

German High-Power Station for Dutch

DETAILS of the giant wireless telegraph station to be erected in Holland by German interests for the purpose of facilitating communication between Holland and her East Indian possessions, according to a contract concluded September 23 between the Dutch government and the Telefunken Company of Berlin, are found in a recent issue of Commerce Reports.

Paul L. Edwards, Commercial Attaché at The Hague, reports that the receiving station of the new plant, which is expected to cost about $2,000,000, will be at Boxmeer, in the Province of North Brabant, and the sending station will be located on a hill at Kootwijk, Province of Gelderland, near Apeldoorn, some thirty-five miles from the receiving station. The sending station will consist of six steel towers, each 210 meters (about 688 feet) in height. The Radio-Nieuws says that the Kootwijk sending station will have the same reach as the German station at Nauen. The installation will be able easily to transmit to and receive from a station of like dimensions and capacity which is shortly to be built at Bandoeng, Java. The distance between the Kootwijk and the Bandoeng station is about 6,830 miles.

It is understood that an engineer representing the Telefunken Company is in Java with a view to supervising the construction of the station at Bandoeng. De Nieuwe Courant said some time ago that all of the apparatus and raw material for the construction of the Bandoeng station were in Berlin ready for shipment at the first opportunity. The apparatus for the station in the Netherlands is not yet completed, but parts are already said to be arriving from Germany.

Standardization of Wireless Before Interallied Conference

IMPORTANT problems involved in the standardization and maintenance of radio communication the world over will be taken by the provisional interallied communication conference which convened in Paris January 25. Under the shadow of the greater peace conference this organization will take up a series of questions relating to radio communication between the allied powers.

The United States Navy representatives are Admiral W. H. G. Bullard, formerly director of naval communications; Captain D. W. Todd, present director of naval communications; Commander M. F. Draemel, in charge of the code and signal section of the naval communication service; Lieutenant Commander E. G. Blakeslee, communication officer on the staff of Admiral Sims; Lieutenant Commander H. P. Le Clair, formerly head of the radio division of the Bureau of Steam Engineering, now radio material officer on the staff of Admiral Sims, and Lieutenant T. A. M. Craven, of the office of the director of naval communications. In the absence of Captain Todd, Commander E. B. Woodworth is acting as director of naval communications.

At this conference all of the allied governments are to be represented and questions of the utmost importance will be discussed concerning the wave lengths to be employed by high-power radio stations, automatic transmission and reception of radio messages at high speed, the call letters to be used for radio communications, the relation of high-power radio telegraphy to the cable situation, and various other matters concerning the transmission of intelligence between the allied countries.

Its primary purpose is to standardize radio communication, and to facilitate the exchange of views relative to the advancement of the art of radio communication for the purpose of insuring the safety of vessels at sea and of serving the needs of commerce in general.

It is possible that the commission may make recommendations to the next International Radiotelegraphic Conference, a meetng of which was called for in Washington in 1916 but was postponed on account of the war. This is a larger body than the provisional interallied communication commission, as it is composed of delegates of virtually all the countries of the world.

Beatty Used Wireless Instead of Guns

THE following are three wireless messages typical of those that Admiral Beatty has been sending across the seas to Kiel these last few days, according to the London Daily Mail.

"Request you will report on sinking of U-93, as same appeared avoidable."

"Torpedoes you failed to send with latest convoy of submarines you will forward by next transport."

"You will stop using your wireless till further orders."

Few who were up with the Grand Fleet for the recent surrender have returned without reverence for the whole attitude and bearing of the British Commander in Chief. Deprived of his Trafalgar, Beatty has been sending wireless broadside after broadside into the Huns. Said a commander at Rosyth, "They are eating the dirt thrown them by Beatty."

Daniels Acknowledges World's Debt to Marconi

THE part Italy played in the war was warmly praised by Josephus Daniels, Secretary of the Navy; Charles E. Hughes, and Major Fiorello La Guardia, U. S. A., at a meeting held January 26 at the Metropolitan Opera House, New York, under the auspices of the Italy-America Society.

Secretary Daniels said in part:

"I wish today to express the obligations which this republic, which the people of every nation, feel particularly to the naval constructors of Italy, for the contributions they have made which have revolutionized naval warfare.

Photo Intern'l

Speculation on communication with Mars and the successful installation of wireless service between England and Australia by Marconi has again attracted world-wide attention to him

"Nor do we forget the debt the world owes to Marconi, who caused the electric spark to leap at the bidding of man and not to be tied to the cable, so that men on ships speak to each other not hundreds of miles apart, but thousands, and space, so far as communication between man and man is concerned, has been annihilated."

Inter-Stellar Wireless a Possibility to Marconi

IN an interview which Harold Begbie, a representative of the London Chronicle, had with him, Marconi discussed the possibility of communicating by wireless "with the stars"—that is, bodies in our own or other solar systems on which there are intelligences.

When asked if he thought the waves of ether were eternal, Mr. Marconi replied: "Yes, I do. Messages that I sent off ten years ago have not yet reached some of the nearest stars. When they arrive there, why should they stop? It is like an attempt to express one-third as a decimal fraction; you can go on forever without coming to any sign of an end. That is what makes me hope for a very big thing in the future." (Communication with intelligence of other celestial bodies.) "It may some day be possible, and as many of the planets are much older than ours the beings who live there ought to have information for us of enormous value. It is silly to say that other planets are uninhabited because they have no atmosphere or are so hot or are so different from the earth. If there were no fish in the sea we should say life there is impossible, and so it is impossible for man." When the interviewer objected that the language difficulty seemed to present an obstacle impossible to surmount, Mr. Marconi replied: "Well, it is an obstacle, but I don't think it is insurmountable. You see, one might get through some such message as 2 plus 2 equals 4, and go on repeating it until an answer came back signifying 'Yes,' which would be one word. Mathematics must be the same throughout the physical universe. By sticking to mathematics over a number of years one might come to speech. It is certainly possible." Mr. Marconi stopped speaking for a moment, and then, as if the matter was something so uncertain that he did not feel it worthy of more than passing mention, said he had often received strong signals out of the ether which seemed to come from some place outside the earth and which might conceivably have proceeded from the stars.

Wireless Stages the World Drama

WHAT appears to be inside "dope" on the radio communication incidents that dramatized the receipt of the news of Germany's surrender is contained in a description from Guy Hickok, of the Eagle Bureau, Paris. He writes:

"A group of lads in olive drab sat in an American wireless receiving station not far from Paris.

"It was a long evening in the early part of last November. The man with the headpiece pinching his ears was thinking of the old days when baseball scores used to click into his little wireless house on board a big fruit-carrying ship. He listened absently to the calls ripping the atmosphere with code that he didn't understand. He had to listen, for no one knew when there might come whispering out of the sky a message that he could understand, a message that he was stationed there for the sole purpose of receiving.

"Suddenly the zip-zip-zipzip of the receiver ceased being a meaningless succession of whispers without sense. It dropped from code to simple speech. It—he listened for awhile—it was incredible. He turned to the others, his face contorted with the effort to believe the unbelievable.

"'Good—! Good-God! It's Germany talking to Foch!' he cried in a strained voice.

"A small shower of cigarette stumps shot into the corner of the room. Every lad in the tiny place sprang up and leaned over the table. It was a long time before any of them moved away—for what they heard there, what they saw the man with the steel bands around his head scribble on the paper they slid under his hand, was one of the most dramatic events in the history of the world.

"Some day this moment of history will be fully written. As these American boys heard it, the tremendous import of the moment was so overpowering that they could scarcely realize what they were hearing. Fragment by fragment the truth dawned upon them.

"Erzberger—yes, Mathias Erzberger—was talking to d Great Headquarters —talking about an armistice. It was the first hint of such a thing. Talking about cessation of hostilities.

"It was not very clear. And there were confusing interruptions. For a time both of the great German sending stations were talking at once. Erzberger was speaking from the Berlin station. And somebody—somebody who hated talk of armistices—was 'jamming the air' from the German station at Nauen. For a time it seemed doubtful if Erzberger would ever get anything said. For the Nauen station would always begin stuttering in time to break up the sense of his sentences.

"At last Nauen relapsed into silence, and what had sounded like a three-cornered backyard wrangle straightened itself out into the magic talk that ended four years of horror.

"But before even the beginning of an agreement was reached another wireless voice interrupted: It was a British ship of war and it wanted to know what was up.

"A deeper British wireless throat broke in and told the first to keep silent.

"Another whisper from the sea, American this time, queried insistently, demanding to know a lot of things. And another command, identified as from the American flagship in European waters, hushed the query.

PIECED FRAGMENTS SPELL VICTORY

"It was a long time unraveling. It came in fragments, half statements—like actual dialogue at a great crisis.

"Erzberger, talking for Germany, wanted armistice discussions opened. Another faction, that in possession of the German wireless at Nauen, would rather eat nails ***au natural*** than talk any kind of peace. Allied headquarters were meticulous. They were not going to snap up any old appeal for an armistice that came along. It had to be a *bona fide* one bound by all kinds of guarantees before they would even glance at it.

"After a period of getting nowhere Erzberger asked permission to talk to the German army chiefs in code. Permission was peremptorily refused.

"There followed a pause, after which Erzberger sent eight long messages, not in code, each of which was answered from German army headquarters by one word.

"Conversation with Allied headquarters began again. This time brass tacks became much more apparent than hitherto.

"They began dickering over the actual means of bringing about a conference of envoys. Germany wanted to send them over the Allied lines in airplanes. Oh, airplanes plainly marked with proper identification of course.

"But Allied chiefs wouldn't have it. No German airplane was coming over their lines with their consent. Immunity would be promised to none. They had had experience with Germans before. And a plane promised immunity could see a lot, and report back. The answer was an uncompromising 'No.'

"Then Germany proposed an alternative.

"'Send your envoys over our lines in a plane of your own,' was the substance of their next proposal.

"Again the Allies answered 'No.'

"Even if the chief should guarantee safe conduct to an Allied plane, individual battery commanders and gunners could not be trusted. The lives of men important enough to be plenipotentiaries were too important to expose thus.

"Then the Allies made a proposal, and the road that the German envoys were to follow in crossing the French lines was laid out. It was the road from Chimay through Fourmies and La Capelle to Guise. And the Germans were instructed to come by automobile and to carry white flags. They were told where the French sentries would challenge them and what they were to do.

"What followed? The conference in the railway car, at which Marshal Foch read to the German delegates the terms that meant—if they did not actually say— 'Unconditional surrender,' everybody knows."

Both Sides of the Government Ownership Question

A Summary of Opposing Testimony Given in the Congressional Hearings on the Alexander Bill

IN the February issue amateur aspects and arguments on the question of government ownership of wireless were given. The present article summarizes the general trend of argument, other than amateur, on the Alexander Bill, as heard before the Merchant Marine Committee of the House of Representatives in Washington from December 12 last, to December 19.

The case for the Navy was opened by Secretary Daniels, with the initial statement: "This is a bill that would give the Navy Department the ownership, the exclusive ownership, of all wireless communication for commercial purposes."

In general substance the remarks of the Secretary of the Navy then attempted justification of the proposal because of the excellence of the radio communication organization which the Navy had builded up during the war, the argument being that only through similar peace-time control by one agency could interference be eliminated. He outlined the "receiving center" scheme on the Atlantic coast, the principal stations being at Belmar, N. J., and Otter Cliffs, Me., these stations being connected by wire with Washington. A control station at the capital also served for the simultaneous operation of the four high-power transmitting stations at Annapolis, Sayville, Tuckerton and New Brunswick.

The plan for recording any violation of regulations which would enable enemy submarines to locate merchant vessels off the Atlantic coast was mentioned, this scheme having provided for daily "logs" kept by 37 "intercepting stations," which were equipped with radio compasses for locating suspicious or enemy stations. The equipment of seaplanes and submarine chasers with radio telephones and listening devices was also reviewed.

The Secretary next told of the purchase of the Marconi and Federal shore stations, excepting the Marconi high-power equipments, which increased the number of naval shore stations from 58 to 111. Commending the Navy for its transactions of commercial wireless business, he then said that it but required the passage of the bill to enable it to continue its control for all time.

Congressmen Green and Edmonds viciously attacked the principle of Government ownership revealed in the proposal for monopoly, immediately after Secretary Daniels ceased speaking. Following this, inquiry was made as to the probable cost of the acquisition, which Mr. Daniels estimated, "somewhere in the neighborhood of $5,000,000," which would not include patents and patent rights, a matter for adjudication in the courts.

A heated controversy arose over the Navy's purchase of commercial ship and shore wireless equipment, Congressman Edmonds stating that "after this committee refused to bring out a bill to purchase wireless apparatus, you utilized the Government's money to purchase this wireless apparatus and took over the commercial systems without the consent of Congress." Mr. Daniels said the action was not in defiance of Congress, but the purchase had been made as a good business proposition with funds available through the naval bill. The discussion then disclosed that the buying proposal so far as it relates to the ship sets, originated with the Shipping Board and that the Marconi Company had at first objected to the sale. Congressman Edmonds stated that the action had embarked the nation on a project which should have had the authority of Congress. "The operation of ships by the Shipping Board is limited to a certain term of years," he said, "whereas you are trying a permanent policy on the Government of having a monopoly of the radio business."

Commander S. C. Hooper, U. S. N., executive officer radio division, Bureau of Steam Engineering, Navy Department, soon afterward received permission from Secretary Daniels to speak about the board appointed to look into the patent situation. First explaining the complications which have arisen over existing radio patents and the arrangement made by the patriotic manufacturers to "call off all patent rights until after the war," he said that several months prior to the ending of hostilities a board had been appointed to settle up the patent situation. Its composition included a representative of the Departments of Navy, War and Justice, with a general policy of trying to see "that everybody gets what is coming to him."

Referring again to the bill itself and questioning Mr. Daniels, Congressman Saunders asked if the present law did not give the Navy everything required for the public protection in time of war. The Secretary replied that this was so. Then, under a hot verbal cross-fire from several members of the committee, Secretary Daniels and Commander Hooper narrowed the argument for ownership down to the problem of interference, which, in their opinion, could only be solved by giving a complete monopoly of radio either to the Government or a single commercial company.

Captain David W. Todd, U. S. N., Director of Naval Communications, opened the first afternoon's session by introducing the amendment to include amateurs in the scope of the bill. This subject was clearly outlined in the February issue and will not be again reviewed here. The Navy's representative then summarized the history of radio regulation by law, and outlined the condition which prevailed up to America's entrance into the war. With this as a basis, his argument was then directed to the economic value of a monopoly in ship-to-shore wireless. For a commercial station to be located and operated alongside a station in Government hands he considered an economic loss, because naval stations must have full crews and be maintained day and night; by permitting them to handle commercial business it looked to him as if the ship-to-shore traffic would gradually drift into the hands of the Government. In the matter of high-power stations, he noted their increase and mentioned how Great Britain had encouraged the English Marconi Company, nearly all privately owned stations in that country being Marconi plants, although there was no monopoly by law. On question from Congressman Saunders, who thought Great Britain's shipping interests gave her more convincing arguments for Government ownership, Captain Todd replied that he expected Great Britain would buy out the English Marconi Company, but added, "I may not have good reasons for believing that."

Congressman Green gave his opinion that if the British Government had such an idea, it was not necessarily a good example for us to follow. Arguing then that monopoly of operation required ownership also, Captain Todd thought the control under the present law too weak, because any foreign Government could secure a license and erect a station anywhere in the United States. Congressman Humphreys said, of course Congress could amend that feature of the law. The naval communication official then voiced his expectation that, at the next international radio conference the consensus of opinion of the nations represented would be for absolute Government operation of high-power stations, or they would call for such strict control that it would amount to the same thing.

Captain Todd thought Government ownership also necessary for the reason that with hostilities impending at some future time the transfer of control might be looked upon as a hostile or unfriendly move. Congressman Humphreys closed the discussion in this point by the statement that it was hoped the United States "would not come into any war of its own choosing except as a defensive matter," and preparation in such case would rather have the effect of letting a belligerent nation know "perhaps he had better not be so quick to embroil us."

It was next pointed out by members of the committee that one section of the bill was so worded that, should the Government take over the stations, owners could only be compensated in the event that a claim was filed within two years. This wording was defective in the opinion of Captain Todd, and the time-limiting clause was stricken out.

Following an extended discussion on the necessity for keeping naval shore station operators idle when they might be, in time of peace, engaged in handling commercial messages, the director of naval communications noted that the present law did not specifically apply to high-power stations, and that it would be a very great waste for the Government to keep its high-power station quiet; that, in short, permission to handle commercial business with these long-distance equipments was very desirable. Various aspects of the possibility of international complications resulting from such practice were discussed, Congressman Edmonds noting that England and Germany and the United States—three great commercial nations of the world—have not owned their wireless. The question rested with the observation of Congressman White that it made a material difference whether governments had forbidden private enterprise in radio or that private persons had not been encouraged by commercial business to build stations.

Lieutenant Cooper, U. S. N. R. F., the former amateur whose discussion of the experimenters' problems was outlined in the February issue, followed at the conclusion of Captain Todd's testimony. In dealing with the high-power situation, he made the broad statement that, due to war experience, the Navy was in a superior position from a practical operating basis. He explained the distant control system of transmitting, by which four operators in one room in Washington operated the stations at Annapolis, Sayville, Tuckerton and New Brunswick. The Marconi station at Belmar and the naval station at Otter Cliffs, near Bar Harbor, Me., were used for receiving. He then added the opinion that the number of high-power stations now on the Atlantic coast was close to the practical limit, stating that the longest wave length at present in use is about 17,000 meters and that he doubted whether any practical working wave lengths were left. In explanation of this statement he noted that Tuckerton used about 8,900 meters and Nantes, in France, used 9,000 meters on some of its schedules, causing interference. The regular wave for trans-Atlantic traffic he gave as 10,000 meters.

On question from Congressman Edmonds, the naval reservist thought 500 to 750 meters difference was required between very sharply tuned high-power stations to prevent interference. He was not prepared to definitely state, however, he admitted, whether with increasing demand for high-power equipments the maximum wave length would not be extended beyond the present 17,000 meters, making more wave lengths available. His concluding statement to the effect that the Navy was ahead of commercial companies in installing the newest long-distance apparatus, met with the rejoinder from Congressman Edmonds that the Navy did not have to exercise any care as to how much money it spends or pays for patents as private companies do.

Commander Hooper appeared next as the Navy's technical officer, paying the fine initial tribute to the commercial and scientific radio men in civilian life which was quoted in full in the February issue. Speaking on the question of interference, he thought that average gradations of 300 meters between stations, practically speaking, would prevent interference; with low-power stations, tuning within 25, or even 15, meters was practicable. In the matter of coastal stations the substance of his argument was that waste was encountered by having two systems and that through Government ownership safety at sea would be best insured. For high-power stations, he argued, Government ownership presented many advantages and on the interference problem, trouble was being stored up if no Congressional action was to be taken. Otherwise, he looked forward to complaints of alleged disrespect to foreign nations becoming a matter to be taken up through diplomatic channels. Commander Hooper thought that with a multiplicity of high-power stations built in different countries an international commission might decide that only one station could be used in a country and commercial interests might lose on their investment of millions. Congressman Edmonds said that this was a matter of commercial risk, and it was no business of Congress to regulate a man's commercial desires.

The technical officer read a review of naval radio activities during the war, dated October 24, 1918. It showed that during the fiscal year, 1,282 new installations for naval vessels had been provided for. Contracts had been made for wireless equipment for about 2,500 new vessels of the Shipping Board. The total number of existing and prospective installations provided for and maintained was in excess of 4,000. Coastal stations maintained and operated totaled 125, of which 75 were commercial plants taken over by the Government. In aircraft radio, 50 service and 40 training 'planes had been equipped, and 60 outfits shipped abroad. Contracts had been awarded for approximately 3,000 complete airplane sets. A large proportion of the report was commendatory of the technical advances made.

At the conclusion of the reading Congressman Edmonds developed the fact that advances in the art had not been made by employees of the Navy Department. The radio telephone was instanced, and Commander Hooper offset the newspaper credit given to the Government for this invention, stating that commercial companies deserved the credit.

Hon. Breckinridge Long, Third Asst. Secretary of State, next appeared as a proponent, saying that the State Department desired to express its entire approval of the substance of the bill. The primary reason, he said, was the international one and its specific application to communications during war. The Chairman inquiring whether there had been any lack of power under the existing law, Mr. Long replied that he was speaking only from the point of view of policy. Mr. Long admitted later that by Congressional act, regulation could be established which would meet the situation.

Commander Hooper, in a supplementary statement, dealt with the patent situation, pointing out its complexity. He explained that manufacturers of wireless apparatus had been required to protect the Government from all infringement claims, a clause which was stricken out of contracts during the war. To attempt settlement of various patents rights, he said, the board which Secretary Daniels had earlier referred to had been created, which would try to decide the merits of claims represented in purchases of apparatus amounting to $30,000,000 or $50,000,000. The decision, when agreement was reached, would then be referred to the Court of Claims. This arrangement being termed irrelevant to the bill's provisions, the navy's technical representative was questioned at length on the lack of reward to the inventor under Government monopoly. He said that he believed inventors "would rather take a chance with the Government," to which Congressman Edmonds returned: "I have not seen any of them rushing around here yet to support the bill."

From the viewpoint of interference at present, Commander Hooper admitted that it was not essential to take the high-power stations, but thought it bad policy to permit commercial companies to build a lot of expensive stations which they might find could not be used because of interference.

C. B. Cooper, New York manager for Kilbourne & Clarke, supported the bill in the interests of his own company and three Pacific coast shipping concerns. The substance of his plea for the bill's passage was the opinion that Government ownership provided the most efficient means of handling the ship-to-shore radio service.

The attack by the opponents of the bill was opened by Edward J. Nally, vice-president and general manager, Marconi Wireless Telegraph Company of America, and president, Pan-American Wireless Telegraph and Telephone Company.

After establishing, on question from the Chairman, that the Pan-American Company was organized a year ago to operate in South America and represented majority American holdings, Mr. Nally called attention to the press statement of Congressman Alexander, which incorporated the Navy Department's reasons for Government ownership. He took exception to the statements that "radiotelegraphy is not a serious competitor of the cables," and "high-power stations are not yet able to receive from one another all day in all seasons," referring to the evidence of the Navy officials before the committee which was strongly to the contrary, especially Commander Hooper's statement on the reliability of communication across the ocean, literally, "now we never miss a message from the other side; that is a fact."

On the question of secrecy Mr. Nally said: "It had always been acknowledged that cable communication possesses the virtue of secrecy, but I was startled some months ago by a report coming from a representative of the Navy Department that there were reasons for the belief that submarine cable communication would be no longer secret, and it was feared that the enemy was copying all of the intelligence which passed between the United States and our allies.

"This was supposed to have been accomplished by laying a short length of submarine cable parallel to and alongside of the existing cable, and continuing the short length into Germany, where signals induced in the short length of cable were easily read by means of recorders and magnifiers.

"This is an old trick, often played on land, but the report was not credited by practical cable engineers; nevertheless, it was an interesting possibility and inasmuch as it was sponsored by representatives of the Navy Department there is no reason why they should not be expected to support the statement in contradiction of their present statement that submarine cable communication is secret.

"It is quite true that 'signals from radio stations are transmitted equally in all directions,' but it is not true

Interior Views of the ARLINGTON STATION

A CLOSE VIEW OF THE SPARK GAP (in centre)

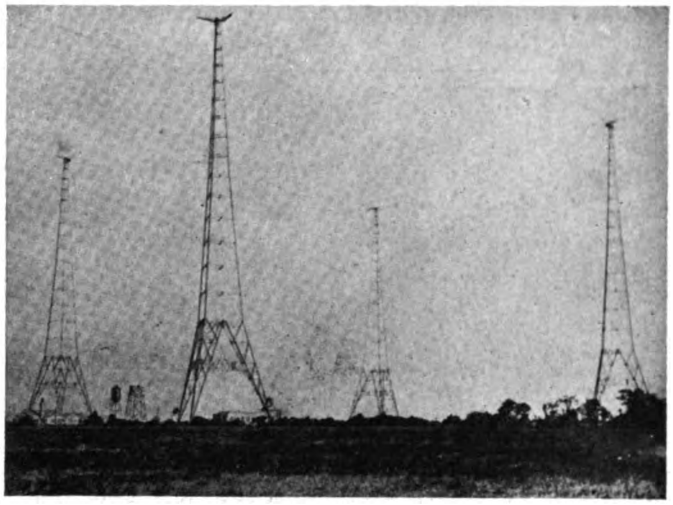
THE TRANSMITTING APPARATUS WITH THE INDUCTION MOTOR IN THE FOREGROUND

THE RECEIVING ROOM

that 'all nations can read the business of all others.' That one individual may not learn the business of another and that one nation may not know the private correspondence of another is the prime reason for the use of codes and ciphers."

He thought it misleading to say that wireless telegraphy is not a serious competitor of the cables, noting that both have distinct and separate value, and that some of the reasons urged against radio would not bear analysis.

He then anticipated the possibility a world-wide range station broadcasting a daily digest of American news in the interests of international harmony, a service impossible of duplication by submarine cables.



The 650-foot towers of the new Annapolis station, the naval high-power installation which was prominently featured in the discussion of the bill

Lieutenant Cooper's testimony was the next subject for his examination. The attempt made by the ex-amateur to imply that sensational progress in the art had been made during the eighteen months of war was misleading, he showed, by analysis of the three most important advances Lieutenant Cooper had related. These were (1) distant control; (2) success in duplex operation; (3) the design of a directional antenna.

Commenting on the first so-called advance in the art, Mr. Nally said:

"In order that the committee might appreciate the correct facts in the development of distant control and duplex operation, and of which apparently some naval officers are not even aware, it is only necessary to mention that transoceanic communication was first established by the Marconi Company between Ireland and Nova Scotia, in 1907, or 11 years ago. The service rendered at that time was limited in character and was utilized mainly by newspapers. The service, however, was so successful that it was opened the following year, 1908, or 10 years ago, to general public correspondence in competition with the existing submarine cable facilities, and many hundreds of thousands of commercial messages were transmitted between Great Britain and Canada, or the United States, without serious interruption, until 1917, when the stations were utilized exclusively for governmental purposes. In passing, I might mention that this same trans-Atlantic service has been released by the British and Canadian naval authorities since the armistice was signed, and is again open to commercial intercourse in competition with the submarine cables.

"This was the first and most important long-distance wireless commercial circuit, and the experience gained in the operation of this pioneer circuit has been of inestimable value to the art in the development and progress of later and higher powered transoceanic wireless circuits. During all this time, when the obstacles appeared almost unsurmountable and when the financial success of such service was seriously doubted by most people, there was no particular interest in international radio communication shown by our Navy Department. It is true that the Navy Department, within the last five years, has built a number of high-power stations, the object of which was to communicate in emergency with our naval outposts, such as Hawaii, Guam, and the Panama Canal; but the first noticeable desire of the Navy Department to engage in commercial international communication, was discernible shortly after circumstances, with which the committee is thoroughly familiar, placed the operation of the Sayville and Tuckerton high-power stations in the hands of the Navy Department. They immediately realized the full possibilities of an international high-power radio circuit, and we have it on record, in the minutes of the previous hearing, that the operation of these stations was so profitable that within a period of two years, and after deducting all naval operating charges, a return of over 30 per cent has been earned upon the investment. This high return, however, was not so much due to the efficient operation of the stations, as claimed by the Navy Department, as to the exorbitant tolls which were charged on the traffic handled. Prior to the severance of the submarine cables connecting the United States with Germany, the tariffs were 25 cents and 12½ cents per word, but during the time that the radio stations were operated by the Navy Department, this tariff was set at 50 cents per word.

"As Secretary Daniels openly informed us, a few days ago, it would be 'good business' for the Navy Department to take over the operation of all high-power radio stations, but it should not be forgotten that this 'good business' was foreseen in 1908 by the Marconi Company and ever since that time we have been striving to improve our high-power machinery, so that we might have an opportunity to fully enjoy the fruits of our labors, and also to earn for our 22,000 stockholders some suitable return on the investment of the many millions which we have placed into high-power stations waiting at this moment to furnish a commercial international high-power service to Great Britain and Ireland, to Scandinavia and Russia, and to Hawaii, Japan, and the Far East."

Claims had been made by the Navy for the specific improvements represented by distant control and duplex operation; on this question Mr. Nally observed: "Radio engineers the world over will corroborate my statement that the Marconi Company was the originator of the schemes of duplex operation and distant control. In the year 1912, the original trans-Atlantic service having become congested with traffic, it became necessary to increase its carrying capacity, and Marconi engineers planned the method by which the capacity of that circuit was doubled by the use of duplex operation; and, since that date—I repeat, this was six years ago—the trans-Atlantic service spoken of, has been continuously worked duplex. At the same date, Marconi engineers arranged for the operating key to be placed some 50 miles away from the transmitting machinery, and this has since that time been the sole manner in which all Marconi high-power stations have been operated. This, gentlemen, is the same distant control of which you have heard Lieutenant Cooper speak in connection with his concentrated telegraph office in the Navy Department Building.

"The American Marconi high-power stations, which were completed on the Atlantic coast in 1914," he continued, "were designated for exclusive duplex operation and are so arranged today. The American Marconi trans-Pacific high-power stations, which have seen commercial operation since September 24, 1914, were designed for duplex operation and were operated by this same system of duplex control. For confirmation of this fact Lieutenant Cooper need only ask several of his ex-Marconi operators now working for him in the Navy

Department Building, and who formerly operated in a highly efficient manner the Marconi trans-Pacific high-power service to Hawaii and Japan.

"We are particularly gratified to learn of the Navy Department's success with the egg-shaped wave," the speaker next observed, "and it will surely interest Mr. Marconi, who invented and patented the well-known Marconi directional aerial many years ago, the effect of which is to project a wave more effective in the direction of the receiving station than in any other direction. All Marconi high-power stations in this country were equipped with this 'egg-shaped wave' producing antenna in 1913 and 1914."

Mr. Nally recalled to the committee's attention the statement of Lieutenant Cooper that the Navy Department was best able, from a practical operating basis, to say what could be done, because the Navy, during the war, had more experience in handling high-power radio traffic. "The radio traffic expert," Mr. Nally observed, "who was singled out by the Navy to directly supervise the operators employed in this central radio station in Washington, where such alleged wonders have been worked, was, up to the date of our entering the war, in direct charge of the Marconi high-power trans-Pacific circuit. He has devoted his career to the problems of radio communication and patriotically offered his services to the Navy Department when they were in need of highly qualified men. We do not claim to have a monopoly on operating talent, but the fact stands out strongly that the Navy Department, in April, 1917, when this country entered the war, was short of really competent, high-grade transoceanic operators and appealed to this company for such men as we had specially selected and specially trained for this important branch of radio.

"It should be realized that there is a vast difference in the efficient operation of a ship-to-shore service and the requirements of a high-powered international service. This latter work is most exacting, and perhaps not more than a few out of a possible hundred average wireless operators have the requisite ability to satisfactorily cope with the heavy and high-speed work encountered on a transoceanic wireless circuit. I have already said that this company had picked a group of specialists, and it was these men the Navy Department made special call for, to assist in the new high-power responsibilities when this country entered the war. With one or two exceptions, the whole of this force volunteered its services to the Navy Department, and they are today to be found occupying responsible positions both in the high-power stations being operated by the Navy Department and also in the central radio office, with which Lieutenant Cooper himself is connected.

"I might also say," he continued, "that the Marconi Company has successfully operated transoceanic radio service at a higher rate of speed than has ever been accomplished by other agencies. The Marconi Company was the pioneer in automatic high-speed transmission and automatic high-speed reception. It has developed this system to a remarkable degree of proficiency. Whereas it is not possible to operate a radio circuit by hand (or, as we term it, manual operation) at more than 30 words per minute, the Marconi Company has successfully and for long periods transmitted by automatic-speed operation at speeds varying from 60 to 100 words per minute. This remarkable advance in the art, as can readily be seen, immediately doubles and even quadruples the capacity of a single circuit. I believe I am safe in saying that the Navy Department still makes use of the old system of manual transmission in the operation of its high-power stations."

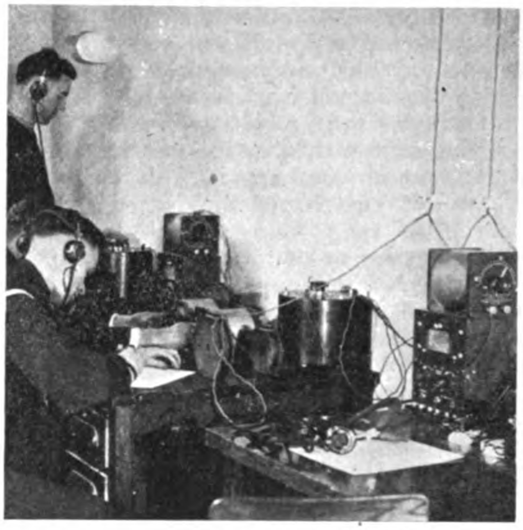
To illustrate that no essential difference in principle existed between radio and wire communication—quoting a statement made by the Postmaster General Burleson—Mr. Nally referred to his personal career of pioneering in all forms of electrical communication, a continuous experience since 1875, and said that he felt no appreciable change when, in 1913, he transferred his activities to wireless. He then touched upon the unfortunate early history of the art in the hands of unscrupulous promoters. The change in conditions he made clear, then, by the observations: "The year 1912 found the Marconi Wireless Telegraph Company of America in full possession of all property formerly belonging to the defunct and dishonest United Wireless Telegraph Company, and the Marconi Company undertook to construct a substantial and highly efficient organization to serve the public, and I can truthfully say that it has succeeding in doing so. The corporation today is as clean as a hound's tooth, it is vigorous and virile, and it has made surprising strides in the last few years and in the face of a most difficult and, at times, most discouraging condition and under circumstances that would ordinarily have caused failure to a less vigorous organization."

Acknowledging the tribute which had been made by Commander Hooper to the Marconi Company and its general manager, Mr. Nally briefly summarized the pre-war and war activities which had earned this credit. He explained how the chain of high-power stations had been built and a highly skilled operating personnel selected and trained for the various transoceanic services, which the Government took over with our entrance into the war. He also noted that the largest source of supply from which trained wireless operators were drawn was represented in the many thousand graduates of the Marconi schools of instruction. The subsidiary company's magazines and textbooks, he noted also, could be found in the homes of nearly every wireless student in the country. Expansion of the Aldene factory to meet Government demands was dwelt upon, more than 3,000 wireless sets being there designed and developed for use in the war.

The object and program of the Pan-American Company was explained in detail from its inception by letters written to the Navy Department and Secretary Daniels by Mr. Nally as the company's president. This correspondence developed the fact that the only opposition to Americans owning and operating wireless stations in South America came from our Government; none from the South American governments; in fact, all of the government officials on the southern continent were enthusiastic and anxious to assist in every way. Secretary Daniels, it was said, was absolutely committed to Government ownership, but the Navy Department hoped the Pan-American Company would go ahead with construction of its Argentina station without any assurance of being allowed to erect the United States communicating station.

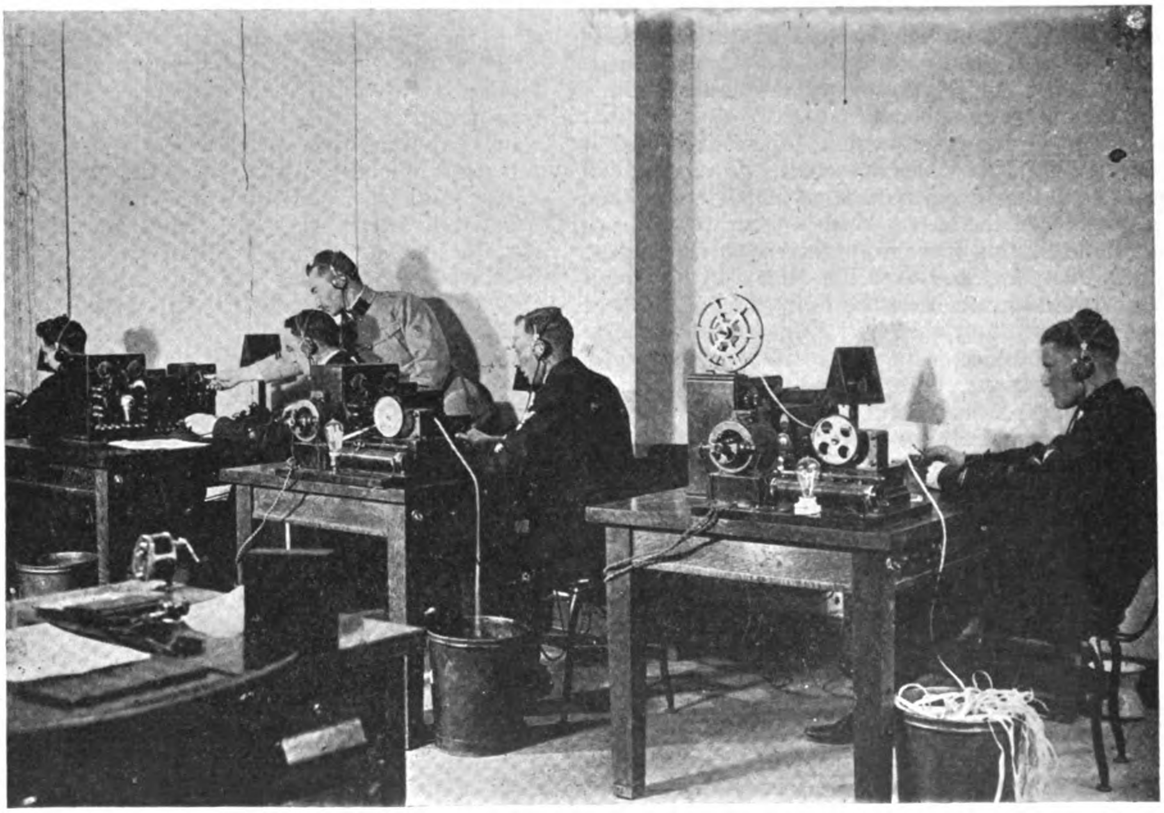
By contrast with commercial wireless agencies of other countries, many handicaps were suffered by United States manufacturers and operators, a fact which was illustrated by a referenee to conditions encountered in Mexico. In this country, Mr. Nally said, the Germans were in full control of the wireless stations. The new Mexican constitution of 1916 provided for Government ownership and, lacking capital for extension of service, the Carranza government fell an easy victim to the wiles of the German Telefunken Company. "There exists no particular prejudice in the matter of doing business with American private corporations," Mr. Nally remarked, "and if our company had been in position to go ahead freely and with the support and cooperation that our business men have a right to expect from the United States Government in their dealings abroad, it might have happened that, instead of there being upward of 25 wireless stations in Mexico under German control, as at present, there would be 25 under American control. And if an American private company were in control in Mexico I am sure that neither Secretary Daniels nor this committee, nor the people of the United States in general, would fail to see anything but a decided military advantage in times

Multiplex Radio Sending



Above: The receiving room of the central control station in Washington which handled all transoceanic naval messages during the war

To the left: Secretary of the Navy Daniels, whose campaign for government ownership was largely based upon the contention that interference could only be removed by centralizing control of high-power station operation



Photos by Int'l.

A general view of the perforating machines for messages transmitted from the centralized station by distant control

of war and an equally valuable commercial advantage in times of peace.

"Although the Mexican Government claims title to all these stations," he explained, "the apparatus is strictly German and there have been German operators in every one of the 25 odd stations. Moreover, there have sprung up Government electrical shops with German superintendents, and the whole system has been supervised by German radio experts who were formerly employed at Sayville and Tuckerton and on the German liners which were interned in this country at the beginning of the war."

Answering the federal ownership advocates who had stressed economic loss and retention of obsolete equipment under private ownership, the Marconi executive maintained that large undertakings were retarded because of the Government's wet blanket of ownership causing uncertainty, and gave instances where high-power apparatus had been scrapped and replaced, to prove that private enterprise made this a practice in the interests of increased revenue.

In closing, Mr. Nally submitted a concrete plan designed to bring to an end costly controversy between the Government and private companies. This scheme gave (a) the Government exclusive right for ship-to-shore commercial wireless, (b) private companies to receive governmental sanction to develop and extend commercial transoceanic and overland wireless, without commercial competition from the Government, and (c) amateur regulation satisfactory to both federal officials and the experimenters. He suggested that the Secretary of Commerce continue the licensing function and a national radio commission representing in its membership of five, federal and private interests, to apportion wave lengths, hear appeals where licenses may be refused or revoked, and recommend to Congress whatever additional legislation may be necessary from time to time. In the interests of national safety he offered, in behalf of the Marconi Company, that only American citizens be employed to operate high-power stations and all to be enrolled in a reserve subject to military call.

Following a considerable period of cross-questioning by the committee dealing mainly with the principle of Government ownership, Mr. Nally was succeeded by David Sarnoff, commercial manager of the Marconi Company and vice-president of the Pan-American Company. Mr. Sarnoff explained in detail the circumstances which led up to the sale of the Marconi coastal stations and ship-sets to the Navy Department, showing that as soon as the Navy obtained complete control of all wireless stations and operations at the outbreak of the war "it followed a line of action which appeared to us calculated to destroy the Marconi rental system and to render the Marconi coastal stations worthless at the end of the war," so there would be no alternative but to sell the coastal stations to the Government.

He then attacked the bill as a measure that would stifle the development of the radio art. He quoted the utterance of Hon. Thomas Ewing, U. S. Commissioner of Patents, who, in 1917, said that if the Government took over wireless it would largely be the end of its development and that, in the "matter of encouraging scientific invention the Government is not a shining success in comparison with private enterprise." Mr. Sarnoff drew attention to the fact that actual operating experience had in most cases been the basis upon which invention and improvement rested, questioning then where the outside technical experts could obtain further experience and knowledge of operating conditions under a naval monopoly of operation. Government salaries, too, were noted to be unattractive to commercial experts and offered no inducement to them to become a Government employe.

Restriction of overland communication was another of the bill's evils, Mr. Sarnoff contended; he illustrated its utility on railroads, showing that in one paralyzing storm the wireless equipment of the Lackawana saved the company $150,000.

"And what shall we say about the future of the wireless telephone, which is rapidly coming to the front," he added, "and to which the world war has given great impetus? Leave the commercial expansion of the radio art unhampered and I am confident that it is only a matter of a few years when we shall have transcontinental radiotelephony. That this is scientifically possible has already been demonstrated; it but remains for technical experts to perfect existing wireless telephone apparatus, and for private enterprise to erect high-power radio telephone stations to effectively compete with telephone lines and materially reduce telephone tolls. It could not help but reduce the rates, because a radio telephone station located in New York and another in San Francisco, capable of continuous transcontinental communication, will be possible of erection at an investment of approximately $1,000,000, and this investment is small, indeed, compared with the investment which the users tie up when talking over a long-distance wire telephone circuit strung between New York and San Francisco, which investment, I should say, roughly, represents $20,000,000."

His next subject was the interference problem, which he termed the keynote of the proponents' arguments, as expressed by Secretary Daniels as the "sole reason" for the proposed monopoly.

"The fact that Navy Department admits that there is no way in which to solve the interference problem except by legislation bears the most eloquent testimony to its poverty in scientific perception and its lack of faith in human genius to overcome this problem," he said. "In my judgment and in the judgment of men whose scientific opinions are infinitely more valuable than mine, the problem of static interference—which interference Prof. Pupin so aptly termed an 'act of God'—was a far more serious and more puzzling and less hopeful problem to solve than that of wave-length interference—'the act of man.'

"In discussing the static problem with radio men I have in the years gone by been told by some of the leading scientific experts that in their opinion the static problem was unsolvable and that there was no way to overcome it, and yet this baffling problem, an obstacle to continuous radio communication over long distances, has been solved, and solved by an American in civilian life, who has never been connected with the Navy Department or any other Government agency.

"Only yesterday I discussed anew with the inventor of the static preventer the question of interference and asked his opinion in the matter. He unhesitatingly replied that he felt confident of the complete solution of the interference problem, and, what is more, he stated that right now, every day, definite and important progress is being made and that the complete solution of what is left of the interference problem is almost in sight.

"If the members of this committee can find an opportunity to refer to the records of the last hearing, held in this room on a similar bill, when the matter of interference was discussed, they will find that what I have said and quoted is confirmed by the opinions expressed by such scientific geniuses and men skilled in the radio art as Prof. Pupin, of Columbia University; Prof. Kennelly, of Harvard University, and Prof. Goldsmith, of the College of the City of New York.

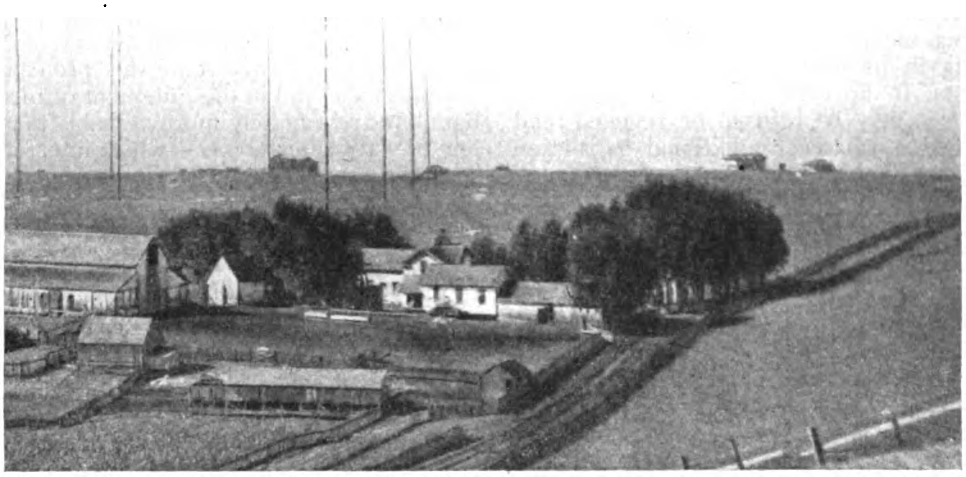
"As against the opinions of leading scientific minds, let me ask which of the proponents of this bill who have thus far appeared before your committee are willing to take issue with these men and their opinions, and to state as a scientific conclusion that the interference problem is unsolvable? And, further, that there is no other way to meet the emergency except by legislating interference out of existence, which, perforce, means limiting the number of stations operating at the same time and consequently limiting the number of messages which can be sent and received at the same time. This would place an artificial barrier on the expansion and development of a public utility, which bids fair, under commercial operation, not only to rival but to surpass every other means of intelligence transmission. If such there be among the proponents of this bill, let me say for his information that "interference" has not singled out radio communication for its sole attack. Mr. Interference has simply come to life again, and is at present in the air but looking down upon the Navy Department, which seems to include the only people fearing his power and who have complained to Congress, seeking his destruction and annihilation through this present bill.

"Our old friend 'interference' seems to have a particular dislike for those who wish to communicate," he added, "and a study of this scientific subject will illustrate that in the early days of land wire telegraphy and telephony they experienced exactly the same trouble from inductive disturbances on the telegraph lines, and cross-talk on the telephone lines. These disturbances were produced in a wire by the operation of neighboring wires. Now, if at that time legislation similar to that now being sought by the Navy Department had been enacted, prohibiting the stringing of telegraph and telephone wires on the same poles and compelling duplicate sets of poles and lines, separated miles apart, would the present high state of perfection of the telegraph and telephone systems have been reached? I think not.

"What happened instead? The scientific minds struggled with the problem until they solved it, and interference from neighboring wires is no longer a problem, and as many wires can be strung on a pole line as the poles will hold, and they can be placed almost as near together as you please. This, of course, means a tremendous saving in the expense of installation and operation of telegraph and telephone lines.

"The honorable Secretary has stated that 'there is a certain amount of ether, and you can not divide it up among the people as they choose to use it; one hand must control it.' Now, the ether knows no national boundaries, or 3-mile limits; it is a common and international medium, and therefore it is not possible for one hand to control it. It is not the American people, and not the American stations which our Government will have difficulty in controlling, because it has the power of the present regulations, and the ability to obtain more regulation if this, in the judgment of Congress, seems necessary. It is the foreign stations that may cause the greatest amount of interference, and we have no means of controlling them except by international agreement, and if we can get along harmoniously with all of our neighbors in the rest of the world by living up to international agreements, why is it impossible or impracticable for the Navy Department to get along amicably, and to work harmoniously with its friends on American soil? One hand—to use the Secretary's phrase—may control all the high-power stations in the United States, but that will not prevent interference from such stations as may be erected in Canada, or in Cuba, or in Mexico, or in any South American country.

"Gentlemen," he continued, "it must be evident to you that this question of interference, which, it has been stated, is the sole reason for this bill, is really not a reason—it is an excuse for obtaining Government ownership and Government monopoly of all radio communication in this country. Our friends the English, who have had experience in telephone lines, do not seem to fear the increas-



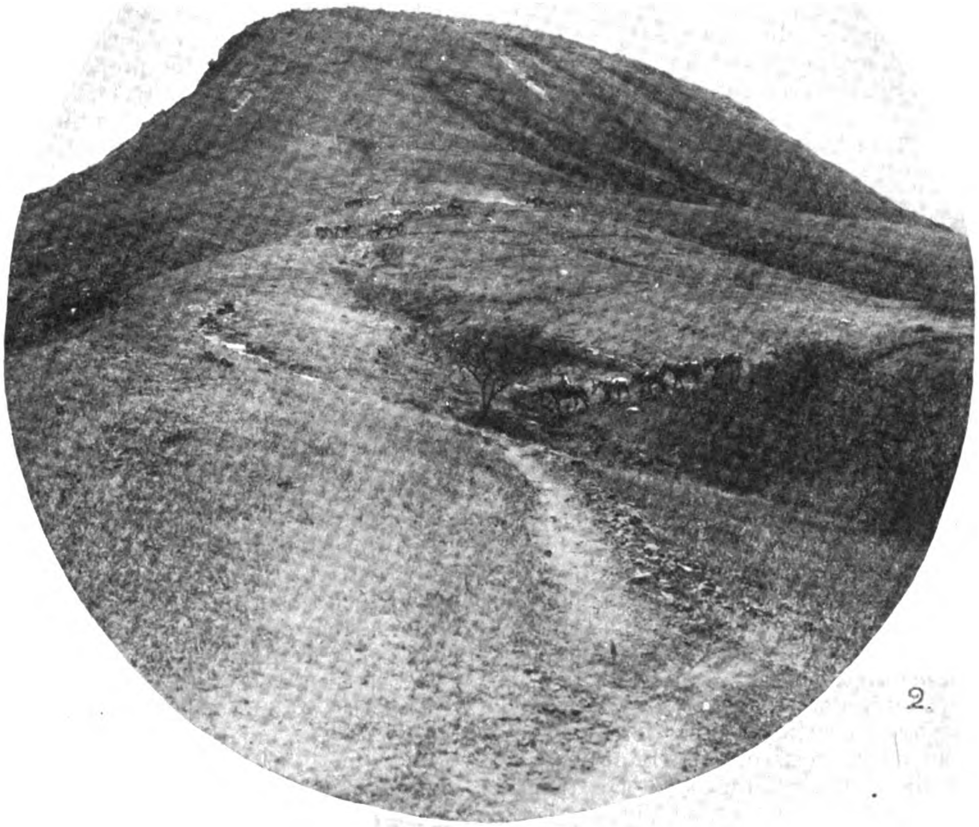
One view of the California end of the Marconi trans-Pacific circuit, for the operation of which it was stated few operators could qualify ing number of high-power stations, and are making extensive arrangements for some long-distance stations, and it is significant, too, that the British Government, while operating telegraph and telephone lines, has not, so far as we know, launched on a policy of Government ownership of high-power radio stations.

"It has been stated to you that only seven countries at present favor or permit private ownership of radio stations, but it has not been stated that these seven countries are the only countries which have helped to develop wireless communication, and, therefore, the proponents of this bill have not claimed that ship-to-shore radio communication would be interfered with by the working of high-power radio stations, and I merely wish to emphasize this important fact that private operation of commercial high-power international radio stations has nothing whatever to do with the interference problem—so far as this problem applies to ship and shore work."

In summary of his remarks on interference, Mr. Sarnoff gave his opinion that the enforcement of intelligent regulation would provide all of the benefits sought with none of the perils to the art the bill imposed.

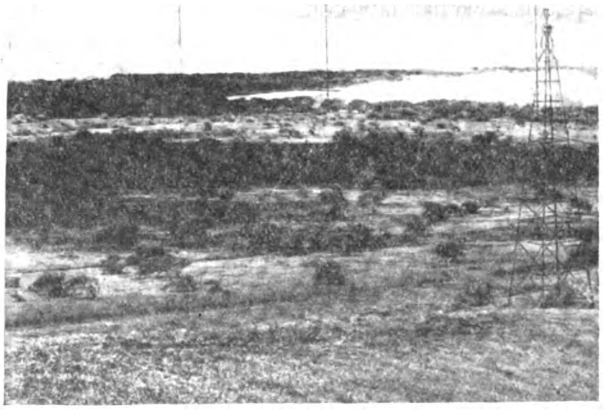
Hon. John W. Griggs, president of the American Marconi Company, was heard next. He observed that the bill seemed to bear most directly and hardest on his company, the most important in capital, property and stockholders, and the oldest company in the United States. "Its present capital," he said, "is $10,000,000, and I think its total assets, as figured on its statement, amounts to something like $12,000,000. It has no bonded indebtedness—it has no indebtedness whatever except the week-to-week current bills that it incurs. It has paid two dividends in the course of the 15 or 16 years it has been engaged in business. It has 22,000 stockholders, the most of whom are residents of the United States, who acquired their stock with the hope and expectation that eventually

1.



1. An extinct crater in Hawaii which serves as the site for mast erection of one of the Marconi stations, illustrating the type of engineering problem encountered in establishing a world-wide wireless system

2.



2. The utility of wireless in Hawaii was emphasized by a representative of the mid-Pacific business men who protested against the Navy's bureaucratic administration; the photo shows the mast line of Marconi's receiving station

the Marconi Company would be able to become a successful competitor of the oceanic cables, and thereby would derive a large income which would justify an investor in waiting 10 or 15, or even 20 years, for a dividend, because he expected when the result was obtained he would reap largely in returns."

The scope of the tansoceanic scheme was explained and the expenditure of $5,000,000 in building stations for the international business. He referred to the taking over of these stations at the outbreak of the war, and now that hostilities had ceased, "in comes the military arm of the Government, the Navy Department of the United States, and asks power of Congress to take away from the Marconi Company not only these stations but all of this prospective business that it has been planning and working and spending money for 20 years to develop and build up. Just when the farmer has planted his seed, plowed his field, and harrowed it, and cultivated his crop, and the corn is ready to husk, the Government comes in and says, 'We want that crop.'

"Well, there must be some justification for such action as this. It is unusual; it is severe. The requisitioning of the property devoted to the uses of commerce or manufacture by citizens of America, the requisitioning of that property is harsh, unusual in time of peace, and ought not to be permitted by Congress except on grounds of public necessity. You cannot take ground for a railroad under the laws of condemnation of any State in the Union, unless it is necessary. You cannot take the right to string telegraph or telephone poles unless it is necessary for the purposes I have named."

Governor Griggs then showed the inconsistency of the Navy's reasons for the supposed necessity. He referred to the fact that arguments in 1917 had been military necessity, reasoning which experience had proved fallacious; the present reason was, therefore, a new one—interference. He did not deal with that technical feature, but he referred to the broad question of interfering with the operation by the Navy of its stations when the nation was not at war. "In time of peace the interests of commerce and business are superior to all the navies of the earth," he noted. "This country does not exist for the benefit of the Navy. The Navy Department exists for the benefit of this country, and no interests of this country should be subordinated to the control of the Navy Department merely because they want it, and substantially that is the only reason that is behind this bill so far as these officers of the radio bureau of the department are concerned.

"Let me ask you this: What law compels the Navy Department to transmit official business or press messages by these stations if they take them over? And if they are willing to transmit messages, if they find that the needs of communication in time of peace, when battleships will lie rusting in harbors—if they find that the needs of their service will still permit some business to be carried on, how will they carry it on? We have had a censorship for the last year and a half. No man could send a message by cable unless it passed a Government censor. No newspaper could get a communication from the front unless it was such as the censor permitted to come over the wires. Do you want to perpetuate a censorship in the Navy Department? If, then, the power, the only power, to operate transoceanic stations is the Navy Department, what newspaper, what correspondent, what business house but what would be at the mercy of some lieutenant commander who had a prejudice against the paper or the correspondent or the business house and did not like it, and who would not take their messages unless they conformed to his ideas of what was proper news to send across? Is there anything to hinder that? The interests of the Navy Department could always be cited as the reason why particular news should not come. I do not hesitate to say that I can conceive of no emergency in time of peace connected with the maintenance and operation of the American Navy or naval stations which would require that they should have first control of long-distance wireless. I say the first use belongs to business and commerce; it belongs to the business people, belongs to the press people, to the commercial people of the United States, and it does not belong to the officers of the Navy Department."

Tying up the proposition for radio monopoly to the policy of Government ownership projected by Postmaster General Burleson, the Marconi Company's president called the bill inadequate and inartistic. He strongly attacked its provisions for compensating station owners after confiscation of their property. The methods of dealing with the person whose property is thus taken he termed unjust, unfair and arbitrary. "I want to call your attention," he said, "to the fact that that does not provide at all for just compensation. Just compensation is what the Government owes for the property taken.

"If you have a company like the Marconi Company, that has been 20 years elaborating, improving, expanding, building up to a certain point of perfection, and then the Government comes in and takes that merely at its scrap-rate value, or its value as it stands, and does not take it as its value as a going company, nor take into account what it is capable of earning, nor take into account the money that has been spent working it up, scrapping of machinery and apparatus, and has taken all these 20 years—you see how much encouragement you are giving people to invest their money in enterprises of this kind, and you see how unjust it is to these stockholders, who have been willing to wait, 5, 10 or 15 years until the company could do this business and earn dividends, to buy them out for the scrap value of their stations.

"Two years ago Captain Todd said significantly that he thought these stations could be got for $5,000,000 and if we waited five years they would be worth $20,000,000," he continued. "There was evidence that Captain Todd knew when these stations were put in operation the large business that we expect was coming to them and the profits that were earned by the company, property which represented merely on the ground $5,000,000, as a going concern would be worth $20,000,000. I do not tie myself to any figures, but you know the difference between the preparation to do business and the doing of business.

"Let us see what it is that they propose thus to take in this arbitrary way. They propose to take the Marconi system in the United States. Well, what is the Marconi system and who is Marconi? I would like to read to you a judicial statement made in 1905 by Judge Townsend, of the United States Circuit Court for the Southern Division of New York, in a patent suit. I read from One Hundred and Thirty-eighth Federal Reporter, page 673:

> The exact contribution of Marconi to the art of spark telegraphy may be stated as follows: Maxwell and Crookes promulgated the theory of electrical oscillations by means of disrupted discharge. Hertz produced these oscillations and described their characteristics. Lodge and Popoff devised apparatus limited to lecture or local experiments or to such impracticable purposes as observation of thunderstorms. Marconi discovered the possibility of making these disclosures available by transforming these oscillations into definite signals, and, availing himself of the means then attained, combined the abandoned and laboratory apparatus and by successive experiments, recognized and developed them into a complete system, capable of commercially utilizing his discoveries.

"Marconi has been recognized by almost all the great scientific societies of the world as the real inventor and discoverer of the practical art. He has had conferred upon him the Nobel prize. The Governments of Great Britain, of France, of Spain, of Belgium, of Russia, of Italy have honored him by reason of that invention. The only two great commercial countries that have persistently refused, so far as their governments are concerned, to recognize Marconi or his patents are the United States and Germany!"

The attitude of the Navy Department toward inventors and patentees was then illuminated by Governor Griggs, telling of the experience of the Marconi Company. "Its patents are supposed to be monopolies," he observed, "and they are given monopolies as incentives to reward invention and discovery; and in that respect we are proud of our monopoly.

"Very early—as early as 1904—the Navy Department began equipping naval vessels with piratical apparatus purchased from companies that made apparatus and sold it embodying the Marconi patents. The Marconi Company protested to the Navy Department against that practice and said it was not fair to a patentee to have the United States Government, which granted the patent, accept goods and buy them from a pirate. It was replied by the admiral, who at that time had charge of the bureau, that the Navy Department took no cognizance of patent rights, except so far as they had been adjudicated by some court. Whereupon the Marconi Company brought a suit against the deForest Wireless Co., and the Marconi patents were sustained as valid, and the deForest Co. was enjoined, and there was a complete judicial determination of the validity of the Marconi patents by Judge Townsend, who was a very able judge.

"Whereupon we meandered again down to the Navy Department and saw the admiral and said to him: 'Sir, we have brought suit against an infringer, and the Circuit Court of the Southern District of New York has declared our patent valid, and we now ask you to cease buying apparatus from these infringers.' And the admiral said: 'We can not recognize the decision of a subordinate court. We must have a decision of an appellate court.' 'Ah, but,' we said, 'deForest will not appeal. He acquiesces in the decision.' To which Admiral Manning replied, 'Well, that is your misfortune.'

"The Navy Department proceeded from that time to this, against our protest, ordering apparatus that embodied the patents of the Marconi Company, which had been adjudicated, and some of them subsequently adjudicated—some other patents—by the Circuit Court of Appeals. They went right on, in spite of decisions, and protests, and everything, ordering apparatus from piratical contractors.

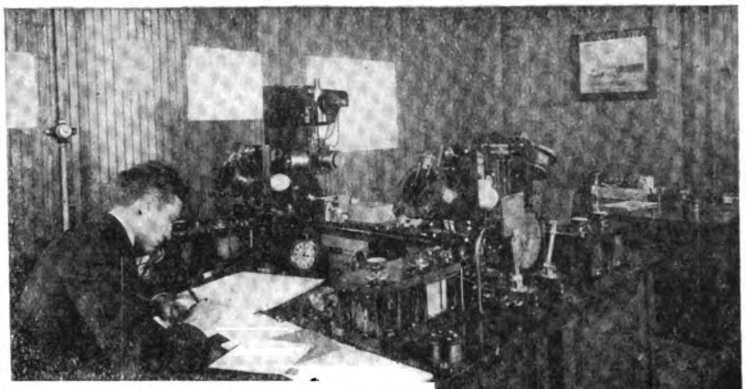
"Well, several years ago, having got no relief whatever from this treatment by the Navy Department, we began suit against the Government in the Court of Claims to recover royalties for the apparatus which they had bought from pirates, the claims arising under the adjudicated patents; and what do you think the Government did? They not only denied our right to any royalty, but they denied the validity of the patents and required us again in the Court of Claims to go through another trial as to validity of patents which had been passed on by the Circuit Court of Appeals, although applications for certiorari to the Supreme Court were refused."

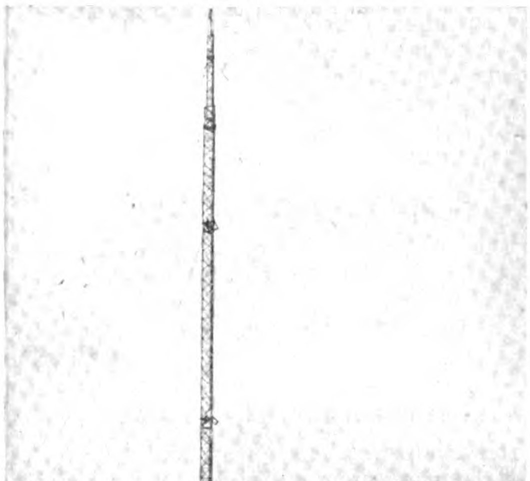
Mentioning the earlier discussion over the policy of having stations in South America controlled by the U. S. Government or private companies, Governor Griggs made the following point: "If in time of war in which the United States or The Argentine is a neutral, a private company is allowed to carry on communication with a belligerent country, it is not a breach of neutrality on the part of the country. But if a Government station in Argentina or in the United States carries on communication with a belligerent Government, it is a breach of neutrality under international law!"

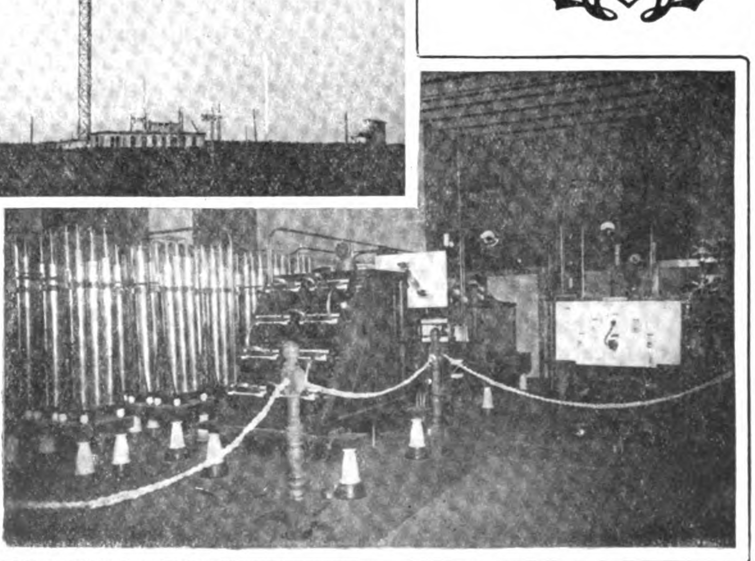
Testimony by Marconi officials concluded with Governor Griggs' statement. Two full days were occupied by other wireless men, mainly in opposition. Aside from

(*Concluded on page 46*)

The Sayville Station





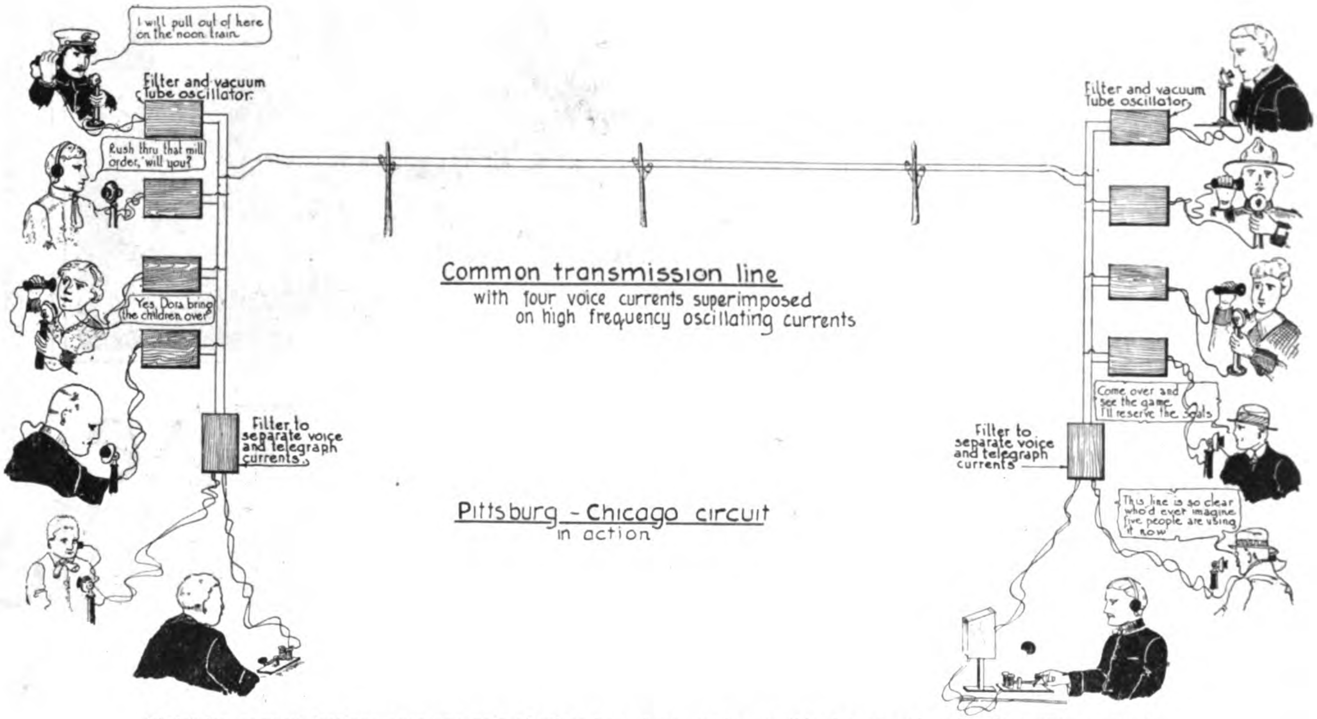


Multiplex Telegraphy and Telephony

The Use of Radio Frequency Currents

WHEN Prof. J. A. Fleming devised the two element valve for the detection of radio frequency oscillations and proved beyond all doubt its rectifying properties and moreover, when deForest and Weagant added the third electrode for further control of electron currents, they blazed the way for a series of developments which have well-nigh revolutionized both wireless and wire communication. The discoveries of Armstrong after a series of intensive experiments, in respect to regenerative amplification engaged the attention of physicists throughout the world. Numerous commercial applications of the vacuum tube followed with astounding rapidity. In fact, new inventions and further applications appeared in such numbers that it has been somewhat difficult even for the scientist to keep abreast of the times. For no sooner had one discovery been heralded forth than another appeared of possibly greater importance.

Telephone engineers were quick to foresee the possibilities of the vacuum tube in wire communication and to apply them in numerous ways to increase the efficiency of land line telephony. An air of mystery, however, has surrounded·their experiments and the layman often is led to believe that the tube was perfected solely through their efforts. Nevertheless it was Fleming's fundamental discovery that made these developments possible, notwithstanding all arguments to the contrary.


I will pull out of here on the noon train
Filter and vacuum tube oscillator
Rush thru that mill order, will you?
Yes, Dora bring the children over
Filter to separate voice and telegraph currents
Common transmission line with four voice currents superimposed on high frequency oscillating currents
Pittsburg - Chicago circuit in action
Filter and vacuum tube oscillator
Come over and see the game. I'll reserve the seats
Filter to separate voice and telegraph currents
This line is so clear who'd ever imagine five people are using it now

Multiplex communications over one pair of wires have been made possible by use of radio frequency currents

It was the adoption of the three element electrode vacuum tube as a repeater and amplifier that made long distance wire telephony possible between New York and San Francisco; and it is because of the ease by which radio or audio frequency currents can be modulated by the vacuum tube that the modern wireless telephone has been developed to such a high degree of perfection. It is an outstanding fact that the art of wireless telegraphy is responsible for great advances in the wire communication, for many of the devices developed for radio use have been found equally applicable to wires. The tube now is being applied in miscellaneous ways in general electrical work.

The vacuum tube is susceptible to so many uses that each particular application of the tube should be the subject of a special article. The two electrode vacuum tube is now sold as a commercial article for the rectification of low frequency alternating currents. The three electrode vacuum tube is not only employed for the detection of damped and undamped electrical oscillations in radio but also is used as a generator of radio frequency currents at frequencies from one-half cycle to twenty million per second. Its use in cascade connection as a radio or audio frequency amplifier is well known to those engaged in radio engineering. Now-a-days, the use of five to eight tubes in cascade is common and not only are enormous amplifications obtained but the factor of selectivity, that is, discrimination between interfering wireless signals, has been remarkably increased.

Recent reports concerning the development of a novel system of wire communication whereby five telephone conversations and two telegraph messages were transmitted simultaneously over one pair of wires between Washington and Pittsburgh have arrested the attention of the newspaper reading public, but the layman is usually told that the apparatus is too complicated to be understood by the unscientific mind. This is true in a limited sense, but nevertheless the system mentioned in published reports is simply an application of well-known discoveries primarily engendered in wireless telegraph research.

A diagram portraying in a non-technical manner the multiplex wire system is shown in figure 1. But the burning question of the layman is, how can several telephone currents be made to pass over the same wires and enter specific receiving apparatus without interference. It would indeed present a difficult problem were it not for the well-known resonance phenomenon encountered in circuits employing the high frequency currents of wireless telegraphy. To illustrate: If we generate radio frequency currents around 50 to 60 thousand cycles per second and we wish to impress these currents upon other circuits, the maximum current flow in the last named circuits will only take place when they are tuned to exact resonance, that is, when their natural period of electrical oscillation is identical with that of the energy producing circuit. Moreover, if we generate currents of several radio frequencies say for example, 30,000, 40,000, 50,000 and 60,000 cycles and connect them to a common line, and we provide at the distance receiving station several circuits tuned to these four frequencies, we find that each particular frequency generated at the transmitter will automatically find its way into the receiving circuit tuned to that particular frequency and none other. The reason for this is that the circuit at the receiving station which is tuned to a particular frequency of oscillation offers the least impedance to that frequency and high impedance to all other frequencies.

Coming back to the simple wire telephone it is well known that the speech frequency currents generated in such circuits by the human voice are not only variable in amplitude, but in frequency as well. The frequencies usually lie between 200 and 2,000 per second. Imagine, then the absurdity of trying to transmit five telephone conversations each of which covered a range of several speech frequencies over the same circuit. Those familiar with the problems of telephoning will tell you that it would not be possible to weed out at the receiving station any one of these particular conversations. The question then arises, how is this done by means of the land line system so widely heralded.

We have mentioned the striking effects of resonance in radio frequency circuits and coupled with this it is well known that current frequencies above 20,000 cycles per second occur at rates to which the human ear is not responsive. Consequently if a telephone receiver is employed to detect these currents, in radio or wire telephony, no sound is heard. But if we modulate the amplitude of such a high frequency current at speech frequencies by a microphone transmitter, the telephone diaphragm at the receiving station through the medium of an oscillation detector will move in accordance with these variations, reproducing the signal being transmitted.

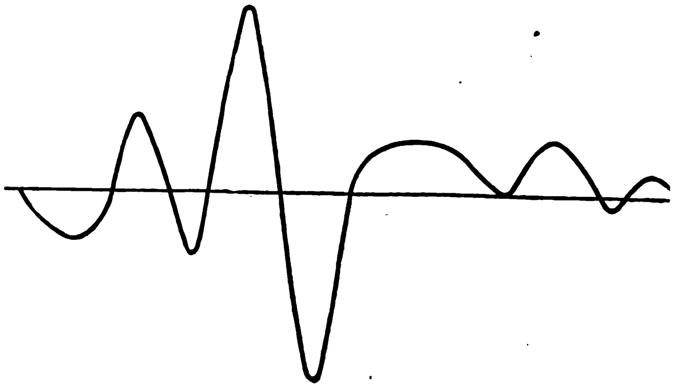


Figure 2—Oscillogram of voice-current transmitted over a telephone circuit

A typical oscillogram of voice currents is shown in figure 2, the variation in amplitude and frequency being clearly indicated. The difficulty of weeding out several such currents at the receiving station is obvious. On the other hand, the unmodified radio frequency current shown in figure 3 has a definite wave form and if several frequencies are transmitted over one wire they can be weeded out at the receiving end of the line by resonant radio frequency circuits. If then, we modulate these radio frequency currents at speech frequencies by an ordinary telephone transmitter as in the oscillogram in figure 4 we obtain an audio frequency variation of the radio frequency current at the receiving station which, through the agency of the vacuum tube amplifier, appears in the head telephone as a speech frequency current. It is by this method that several telephonic conversations are carried on simultaneously without interference.

At the transmitter the grid and plate circuits of a vacuum tube are connected for the generation of radio frequency currents of any desired pre-determined frequency. Either the grid or plate circuit of the tube is connected to a microphone transmitter for speech frequency modulations of the line current. These modulated currents, whose frequency remains substantially constant, but whose amplitude varies as the frequency of the speech currents, are induced in the wire line and are weeded out at the receiving station by vacuum tube amplifiers, the grid circuits of which are made resonant to a particular radio frequency. Owing to the extreme sensitiveness of these amplifiers, very feeble line currents give good signals at the receiving station.

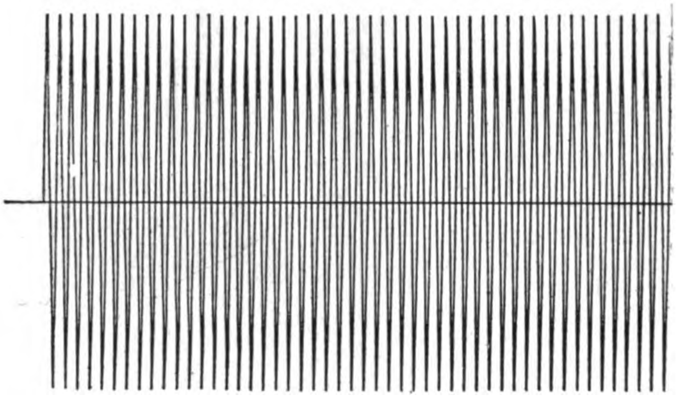


Figure 3—Oscillogram of a high-frequency current

No particular installation was made between Washington and Pittsburgh, but the toll line carrying these multiplex currents extends from the Tuxedo test station just outside of Baltimore, Md., to the Brushton station just outside the city of Pittsburgh. From Washington to Tuxedo and Pittsburgh to Brushton there are provided as many ordinary telephone circuits as are required for the ordinary and multiplex use of the toll lines between Tuxedo and Brushton—in this particular case five. These five circuits do not in any way differ from ordinary telephone circuits either from the standpoint of talking, signaling or operating. The Brushton and Tuxedo stations contain the vacuum tube generating apparatus and the current filters for the various radio frequencies.

Telegraphic currents sent over the wire do not affect this apparatus, for since these currents occur at an audio frequency and the telephone circuits are responsive to radio frequency currents only, no interference results. It has been possible for some time to take two adjacent metallic telephone circuits and to connect them to provide an additional phantom circuit. It is also possible to employ these four wires for a telegraph circuit without interference with the telephonic currents, but in the system cited two wires are employed for multiplex communication without interference. It should be understood that it is through the resonance phenomena accompanying high frequency alternating currents that such a system is possible and, moreover, it is the simplicity of the vacuum tube as a generator of high frequency currents and its sensitiveness as a repeater and an amplifier that makes this non-interfering common highway feasible.

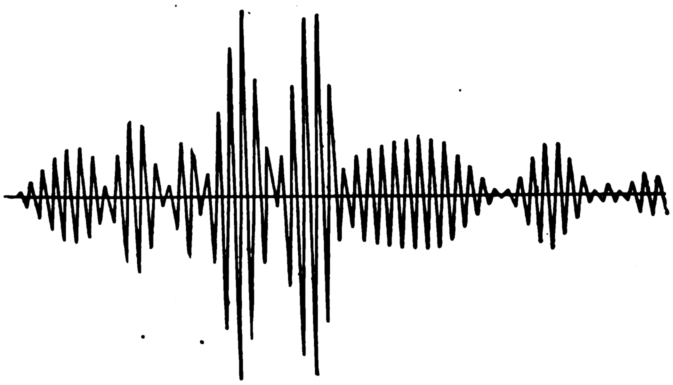


Figure 4—Oscillogram of a high-frequency current modified to transmit a voice-current

It is safe to prophesy that the cable soon will employ this system of communication.

The Weagant Oscillation Valve

A Striking Improvement on the Original Fleming Oscillation Valve

Roy A. Weagant, chief engineer of the Marconi Wireless Telegraph Company

LITTLE is known of the exhaustive researches of Roy A. Weagant, Chief Engineer of the Marconi Wireless Telegraph Company of America, in connection with the design and practical application of the three-electrode oscillation valve. With the war ended it is now possible, however, to describe some features which should be of great interest to radio men. Among his numerous discoveries is a striking improvement on the original Fleming oscillation valve revealed in a recent U. S. patent. The fundamental construction of the new tube is indicated in figure 1, where a plate P and a filament F are enclosed in a vacuum chamber as usual. Mounted externally to the bulb is a metallic electrostatic control element, K, which is placed parallel to the electron stream. An essential characteristic of the tube is that the control element K is placed so that its field acts at right angles to the electron stream, for otherwise the valve becomes inoperative. It was the inability of other experimenters to recognize this all-important fact which caused their experiments to be unsuccessful. Other important factors contributing to stable operation are the spacing of the plate in respect to the filament, and the material of both.

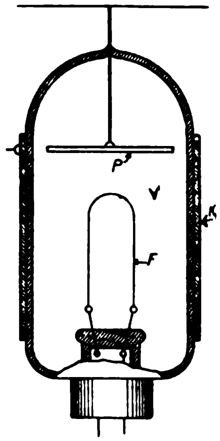


Figure 1—Cross section of the improved valve detector

Figure 2 shows an experimental type of the valve in which the plate P is a pointed piece of specially selected wire. In practice, the external element K may be plated on the glass, but it is not necessarily so attached. This tube has shown some remarkable operating characteristics, chief among them being its stability and sensitiveness as compared with previous types of bulbs. It may be employed in any of the well known circuits for cascade radio or audio frequency amplification, or regenerative amplification for damped or undamped wave reception.

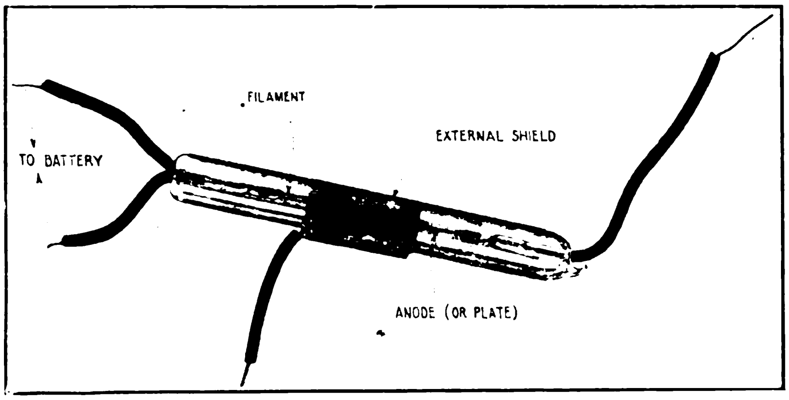


Figure 2—Experimental type of Weagant's oscillation valve

A wiring diagram showing the use of the tube in a simple circuit is shown in figure 3 where the filament F as usual is heated by battery A-1 and the current regulated by the rheostat R-1. The plate circuit includes the battery, and telephone T shunted by a variable condenser C-4. The receiving transformer is indicated by the primary and secondary coils 1 and 2 respectively, with the loading inductance L-3, and the shunt condenser C-5.

In addition to the circuits generally employed in connection with three element oscillation valves, Mr. Weagant has developed the specialized circuits shown in figures 4, 5 and 6. The circuit in figure 4 can be made to generate oscillations in groups at frequencies above or below audibility and therefore can be employed for wireless reception by the beat phenomenon. In the circuit shown in figure 4 the vacuum of the tube is such that the application of 100 volts or less between the plate and filament will produce ionization. In later types of circuits a vacuum of a very high order is preferred.

An important addition to the figures 4, 5 and 6 is the use of a resistance in the plate circuit R-2 shunted by variable condenser C-3. When this resistance is of the order of that of the internal resistance of the tube, it enables the operator to obtain an adjustment so that minute electrical impulses impressed upon the tube cause a great increase in current through the telephone T. This resistance contributes materially, in tubes of low vacuum, in obtaining an adjustment whereby automatic interruption of the local plate current is secured, causing the valve to generate alternating currents in groups. The inductance 3 in figure 4 gives marked amplification of the incoming signals. By its use, the frequency of the plate circuit may be adjusted to correspond closely to that of the grid secondary circuit. Connected in this way, the valve generates sinusoidal oscillations without depending upon ionization and the tube is therefore preferably highly exhausted. The more perfect the vacuum the better the results.

When the apparatus in these diagrams is employed for the reception of spark signals their circuits are adjusted just to the verge of oscillation, but for undamped waves, they are set into oscillation at frequencies slightly different from that of the incoming signal producing beat currents.

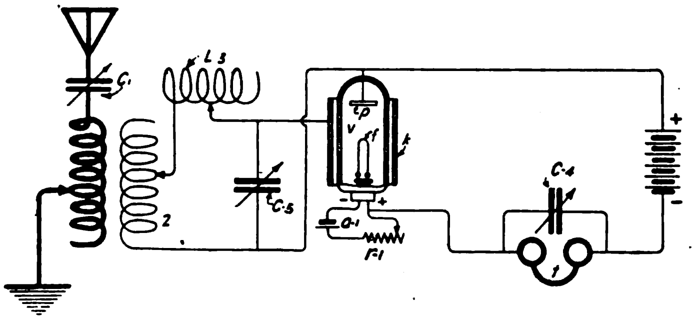


Figure 3—Simple circuit for the Weagant valve

An odd circuit devised by Weagant which is productive of good results is that shown in figure 5, where the antenna is coupled to the plate circuit rather than to the grid circuit. Coupling between the plate and secondary circuits is provided by the wire 10 tapped on to the coil 3. This circuit is applicable to the production of powerful oscillations for transmitting purposes. The modified circuit in figure 6 shows electrostatic coupling between the secondary and plate circuits through the medium of condensers.

Tubes of this type prove very efficient as generators of undamped oscillations for radio telegraphy or telephony.

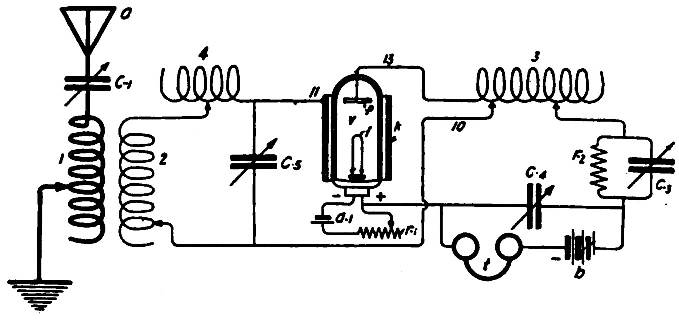


Figure 4—Circuit for damped or undamped wave reception

Tubes giving an output current of 50 watts have been constructed. They are found to operate continuously with great stability. A battery of such tubes may be connected in parallel with good results. Any of the circuits heretofore employed in connection with cascade amplification are thoroughly applicable to the improved valve with the external control element.

Very basic claims have been granted to the patentee. The specifications were filed April, 1915, and granted December 31, 1918. Extensive experiments were made previous to the filing of the application and it is therefore obvious that the work of Mr. Weagant antedates the experiments of all other investigators in this particular branch of radio. The scope of some of the claims may be understood from the following quotations:

"In a vacuum tube device, a vacuum chamber, two elements within said chamber, means for heating one of said elements, means for producing an electron stream between said elements, an electrostatic control element outside said chamber, the field of force of the outside element being at an angle to the electron stream between the interior elements and the outside element being located near enough to the source or stream of electrons to usefully vary the space charge due to said stream.

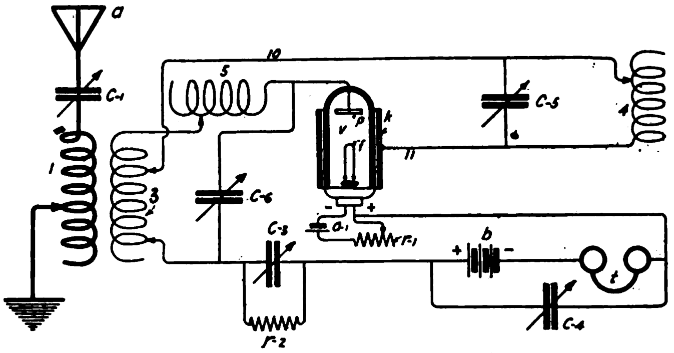


Figure 5—Circuit for transmitting or receiving purposes

"A radio frequency signaling device comprising a vacuum chamber containing two elements, means for heating one of said elements, and an electrostatic control element outside said chamber, the electrostatic field due to said control element being at an angle to the electron stream within the vacuum chamber and thereby capable of producing useful variations therein.

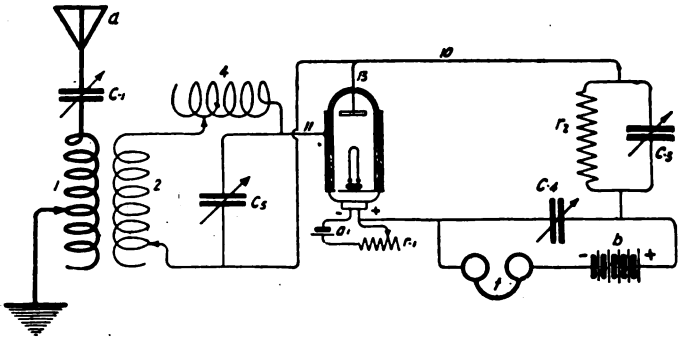


Figure 6—Simplified circuit for beat reception

"A radio frequency signaling device comprising a vacuum chamber containing means for producing a stream of electrons, and an electrostatic control element outside said chamber adapted to project a field of force into the space within the chamber at an angle to said stream of electrons."

Feature Article for the April Wireless Age

A Simple Four Valve Cascade Amplifier for Radio Reception

Practical Wireless Instruction

A Practical Course for Radio Operators

By Elmer E. Bucher

Director of Instruction, Marconi Institute

PART II—ARTICLE III

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EDITOR'S NOTE—Part 1 of this series of lessons began in the May, 1917, issue of THE WIRELESS AGE. Successive installments were devoted to the fundamental actions of radio transmitting and receiving apparatus for the production and reception of damped oscillations.

Part 2, the present series, will deal with undamped wave generators, including bulb transmitters and receivers for the reception of undamped oscillations. The direction finder and other special appliances employed in radio telegraph work will be treated fundamentally. A discussion of the basic principles of wireless telephony will terminate the series.

The outstanding feature of the lessons has been the absence of cumbersome detail. The course will contain only the essentials required to obtain a government *first grade commercial license certificate* and to supply the knowledge necessary to become a first rate *radio mechanic*.

RADIO FREQUENCY CHANGERS

(1) In the two types of radio frequency alternators previously described—the Alexanderson and Goldschmidt machines—currents of the correct frequency for direct connection with the antenna circuit were generated within the machines, but in the system now to be described, a comparatively low frequency alternator is employed to generate the initial radio frequency current, the frequency being increased by means of **mono-inductive transformers** termed **radio frequency changers.**

(2) The principal advantage of the frequency changer system lies in the fact that since the initial frequency generated by the alternators is comparatively low, the generator armature may rotate at reduced speed, and the problem of design is accordingly simplified. Then by means of specially designed transformers, the frequency is increased to a suitable value for the various wave lengths employed in radiotelegraphy.

(3) The efficiency of the system decreases considerably as the number of steps is increased. But these transformers provide a fairly simple means for increasing the oscillation frequency, and permit a non-arcing control of the antenna currents—a desirable feature in high power transmitters.

(4) Various systems of frequency transformation have been devised, but it seems that the Joly-Arco or the Arco-Meissner systems are favored for commercial use, but they have not been widely adopted.

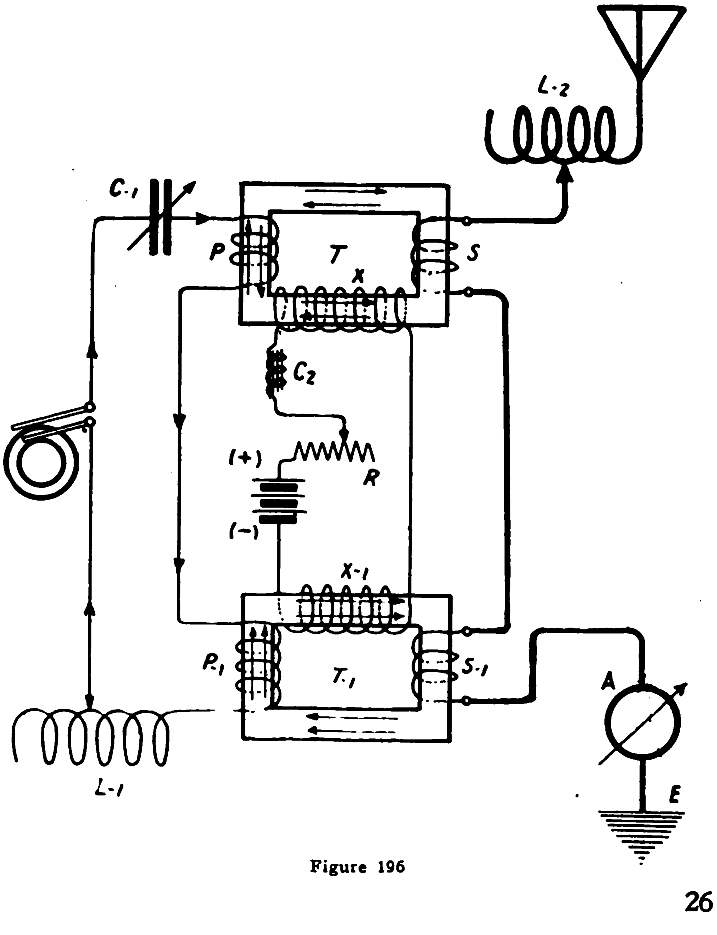

Figure 196

OBJECT OF THE DIAGRAM

To show the fundamental circuits of a single step radio frequency changer.

DESCRIPTION OF THE DRAWING

The radio frequency alternator to the left of the drawing generates at the frequency of 10,000 cycles per second. It is connected through the condenser C-1 and the inductance L-1 to the primaries P and P-1 of two radio frequency transformers T and T-1, respectively. Their secondaries S and S-1 are connected in series and in series with the antenna system comprising the loading inductance L-2, an aerial ammeter A and the earth connection E. Two DC excitation windings X and X-1 fed by a storage battery or DC generator are employed to saturate the cores of T and T-1. A regulating rheostat R enables close regulation of the core magnetism.

OPERATION

By proper disposition of the primaries P and P-1 and keeping in mind that the cores of T and T-1 are fully saturated by the DC winding, it is evident that the **transformer cores act inductively upon the secondary only when the current through their primaries flows in a certain direction.** For when the flux generated by the primary winding P-1, for a complete half cycle of the radio frequency current from the alternator, flows in the same direction as the flux supplied by the DC excitation winding, there is practically no increase in the core magnetism and consequently no effect upon the secondary winding S-1. But at the same time the flux generated by the primary winding P opposes the flux in the core T and a peaked reduction of magnetization takes place as will be shown in figure 201. **This reduction of flux followed by subsequent increase to the normal degree of saturation (which occurs upon the termination of the half cycle) induces a cycle of current in the secondary winding S.** For the next half cycle from the radio frequency alternator, transformer T-1 becomes active and transformer T inactive. **Therefore, for every complete cycle fed to the transformers by the radio frequency alternator, two complete cycles are induced in the antenna system.** The antenna frequency of a 10,000 cycle alternator will be 20,000 per second corresponding to the wave length of 15,000 meters.

SPECIAL REMARKS

(1) Each transformer in the frequency changing system comprises an annular or rectangular closed **iron yoke** composed of **thin laminated iron sheets** so constructed that each part is seamless and has the form of the complete yoke. The thickness of the sheet decreases with increase of frequency.

(2) The variation of flux generated by the alternator has a tendency to induce high voltages in the excitation windings fed by the DC dynamo. To reduce these E.M.F.'s to a safe value, the excitation coils are divided into groups connected in parallel. A DC excitation generator of low voltage is then employed.

(3) Maximum efficiency is secured from frequency changers when the effective number of ampere turns for the radio frequency winding is approximately equal to the ampere turns of the DC winding. The former should not exceed the latter by more than 20 per cent.

(4) Magnetic leakage must be reduced to a minimum, likewise the iron and copper losses. The windings must be uniformly placed over the whole length of the yokes and in case of very large powers, the iron yoke should be constructed of individual insulated packs of sheet metal with intervening air spaces. The transformer is then submerged in oil which is forced between the windings and the packs of sheet metal.

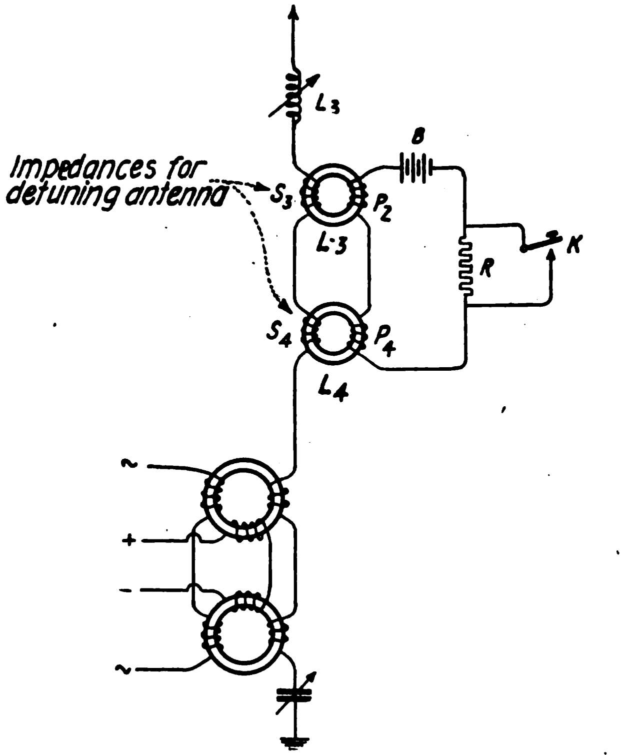

Figure 197—Method of controlling the antenna current, suggested by Arco and Meissner. One way impedances L-3 and L-4 have their secondaries connected in series with the antenna. Their primaries P-2 and P-4 are connected to the direct current source B which also includes the resistance R and the shunting key K. By proper adjustment of the DC magnetising current through P-2 and P-4, the self-induction of the windings S-3 and S-4 may be made to vary greatly simply by change of flux through the iron. Hence, the electrical constants of the antenna circuit can be so selected that when the key K is closed, the self-induction of S-3 and S-4 is reduced by such an amount as to place the complete antenna system in resonance with the last group of radio frequency changers. But one secondary winding is active in impeding the antenna current for a half cycle, that is, the winding S-3 impedes one half cycle and the winding S-4 the following half cycle.

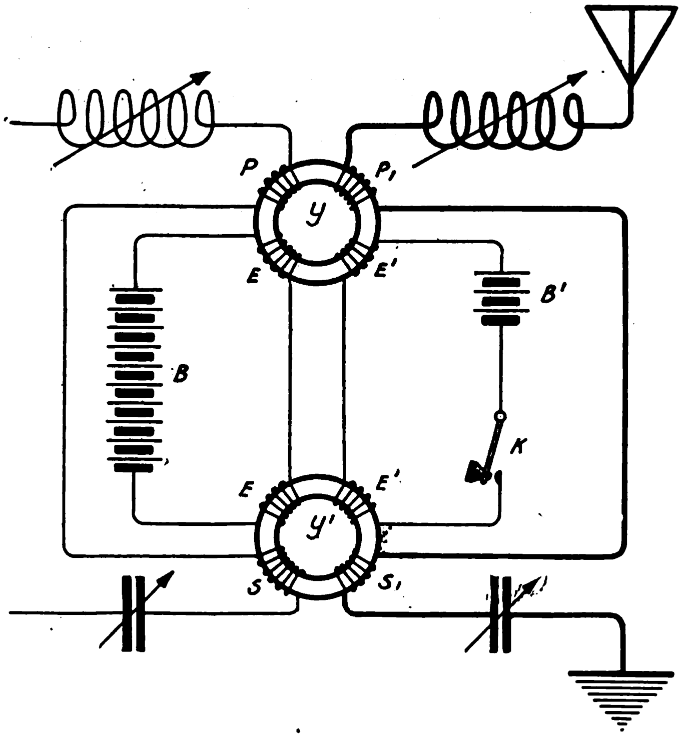

Figure 198—Divided control circuit of the Arco-Meissner system in which the cores of the last step of radio frequency changers are partially saturated by the DC excitation windings E, E, fed by the battery B. The coils E', E', provide the additional magnetising force required to saturate the core or to control the flux in the yokes Y and Y-1 in accordance with any particular set of requirements. The key, K, may be replaced by a magnetic interrupter for producing tone frequency signals or a battery of microphones for speech transmission may be placed in the same circuit to vary the antenna currents at speech frequencies.

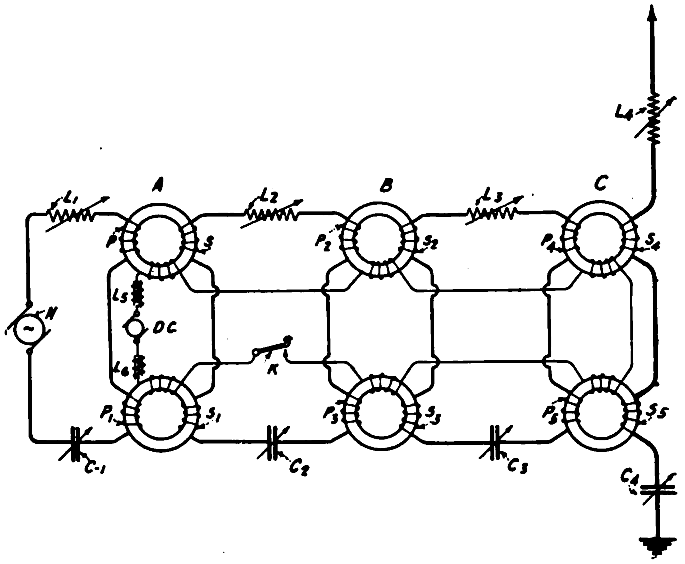

Figure 199

OBJECT OF THE DIAGRAM

To show the circuits of a three-step radio frequency changer system.

DESCRIPTION OF THE DRAWING

Three groups of **frequency transformers** A, B and C are connected in cascade. They are fed from a direct current source marked DC which through their excitation windings **saturate** the cores. The inductances L-5 and L-6 serve to prevent the flow of radio frequency currents back to the DC generator. The primaries of group A are connected to the radio frequency alternator N as usual. Secondaries S and S-1 of group A are connected to the primaries P-2 and P-3 of group B. Similarly, the secondaries of group B are connected to the primaries of group C. The secondaries of group C are connected to the antenna system.

The intermediate circuits of the transformers A, B and C are tuned to the requisite oscillation frequency by inductances L-2, L-3 and condensers C-2, C-3. A key K is inserted in the DC excitation circuit for signaling purposes.

OPERATION

If the frequency of the alternator N is 10,000 per second, a frequency of 20,000 will be developed in the secondary of group A which will be increased to 40,000 in the secondary of group B and to 80,000 in the secondary of group C. The antenna is carefully tuned to the latter frequency which corresponds to the wave length of 3,750 meters. The operation of this method is no different than that explained in connection with figure 196 except that three steps are connected in cascade. Resonance with the alternator frequency is obtained by the variable inductance L and variable condenser C-1, that is, the complete circuit N, L-1, P, P-1, C-1 is made resonant to the alternator frequency. Similarly the circuit S, L-2, P-2, P-3, C-2, S-1 is made resonant to frequency of 20,000 cycles, and the circuit S-2, L-3, P-4, P-5, C-3, S-3 to the frequency of 40,000 cycles. The antenna system is tuned to resonance with the last named frequency by the variable inductance L-4 and variable condenser C-4.

SPECIAL REMARKS

(1) To simplify the process of tuning, Arco and Meissner have shown a circuit wherein variable resistances are included in the radio frequency circuits to **decrease the sharpness of resonance.** After the resonance adjustments are roughly made the resistances are cut out until maximum resonance is secured.

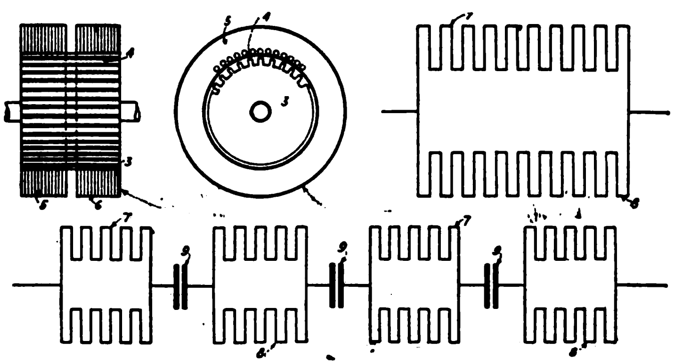

Figure 200

OBJECT OF THE DIAGRAM

To show the constructional details of the Arco-Meissner radio frequency alternator.

DESCRIPTION OF THE DRAWING

The rotor indicated at 3 consists of a **toothed wheel without windings** driven at a very high speed. The poles which are formed at the teeth are of equal polarity and **the generation of radio frequency currents** is secured by **undulations of flux** and not by a reversal which is the case of an ordinary alternator.

It has been found to contribute to the efficiency of the generator to divide the generator systematically in the middle at right angles to the rotor axis so that equal stator halves 5 and 6 are obtained.

As shown in the detail in the upper right hand corner, the windings of the two winding halves 7 and 8 are preferably arranged in parallel in order to reduce the self-induction of the generator and to keep the voltages developed by resonance within a safe value. In order to reduce further the difficulties of insulation due to high voltages, **each stator half in generators of high power is divided into an equal number of sections** and the two corresponding sections of the two armature halves are in each case arranged in parallel as a group as shown in the lower part of the drawing.

The resulting groups are preferably arranged in series with condensers 9 placed between each group. This arrangement reduces materially the equalizing currents which occur in the parallel arrangement of the armature halves due to **slight** inequalities of the winding. By this design the voltage between the entire windings and the stator is no greater than the voltage between an individual partial winding and the stator.

In generators of large power, means are provided for conducting cooling water through the iron of the stator.

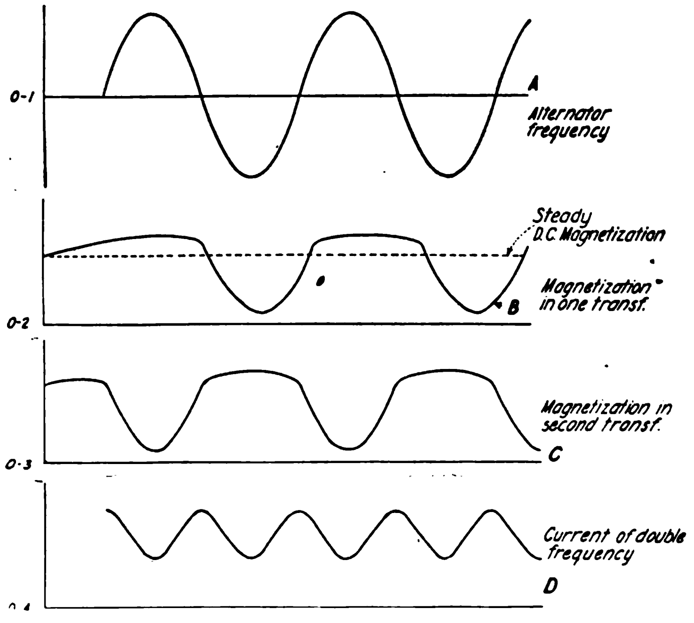

Figure 201—Series of curves showing graphically the phenomena involved in the induction of currents in the frequency changer system in figure 196. Graph O-1 indicates the alternator frequency and the dotted line in graph O-2 the steady DC magnetization in the cores. The curve B in graph O-2 shows the magnetization for a half cycle in one transformer and the curve C of the graph O-3 the magnetization in the second transformer. When the flux generated by the radio frequency current has the same direction as that in the DC excitation winding, the core magnetism is slightly increased, but when these fluxes oppose, a large reduction occurs which induces currents of double frequency in the secondary winding. This current is shown in the graph O-4.

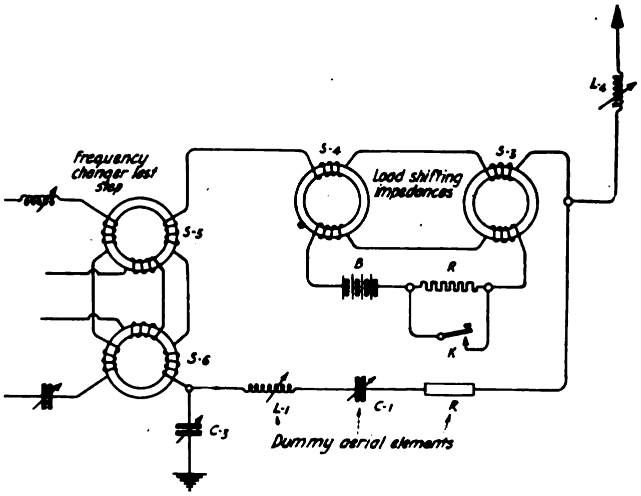

Figure 202

OBJECT OF THE DIAGRAM

To indicate the circuits of a load shifting device whereby the output of a radio frequency alternator is alternately shifted from the antenna circuit to a dummy aerial circuit during a signaling period.

PRINCIPLE

Detuning of the antenna circuit would, in the ordinary system, take the load off the radio frequency alternator whenever the signaling key is open. This may cause the alternator to increase its speed to such a value that it will be out of resonance with the antenna circuit, but if the load is shifted to an artificial antenna circuit during the non-radiating periods of the antenna circuit, the speed and output of the alternator remain constant.

DESCRIPTION OF THE DRAWING

The load shifting impedances are indicated at S-4 and S-3 which perform the same function as those indicated in figure 197. There is shunted around these impedances **an artificial aerial circuit**, including the inductance L-2, the variable condenser C-1 and the ballast resistance R.

OPERATION

The inductances and capacities of the antenna system and of the dummy aerial circuit are selected so that when the key K is closed, the **self-induction of S-4 and S-3 are reduced by an amount that will place the antenna system in resonance with the radio frequency changers.** Simultaneously the reduction of the self-induction of S-4 and S-3 detunes the artificial aerial circuit permitting the normal flow of antenna current. When the key K is raised, the reverse operation takes place, the load circuit being placed in resonance with the radio frequency changers and the antenna detuned.

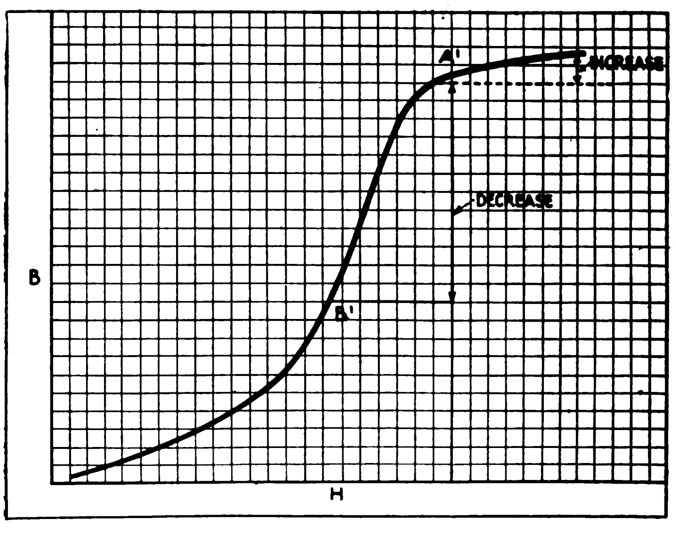

Figure 203—Characteristic magnetization curve of transformer core. H represents the ampere turns of the DC winding, and B the resulting flux through the core. Point A' called the "knee" of the curve, is approximately the point of saturation. It is clear from the curve that if the flux of an alternating current is superimposed upon DC flux (while the DC magnetization is adjusted to the point A'), one half cycle of the alternating flux will cause a slight increase in the total core flux and the next half cycle a marked decrease.

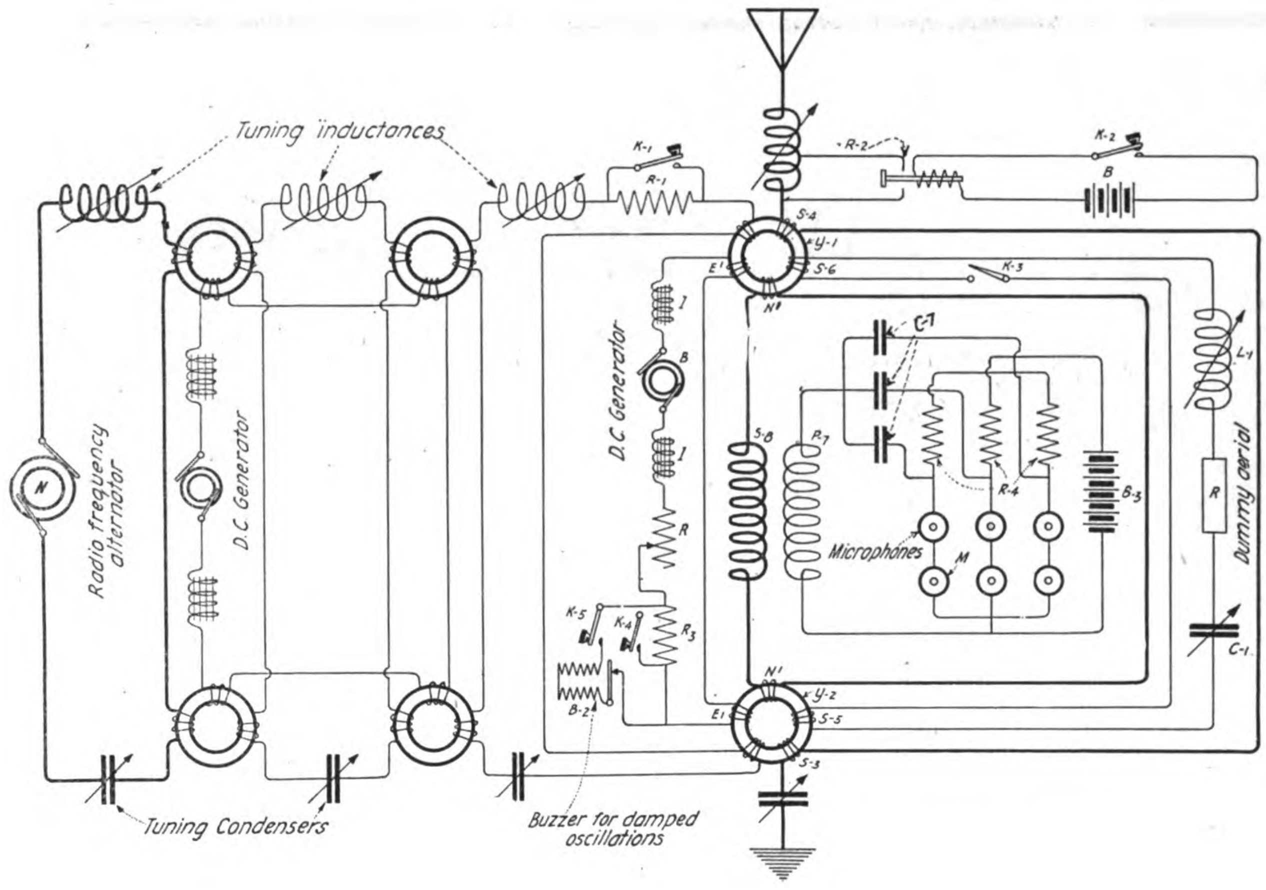

Figure 204

OBJECT OF THE DIAGRAM

To indicate the complete circuits of the radio frequency changer transmitting system for telegraphing by damped or undamped oscillations, or for wireless telephony.

DESCRIPTION OF THE DRAWING

The radio frequency alternator N is connected to the primary circuit of a three-stage radio frequency changer system, the last state being fitted with special circuits for **control of the antenna currents at speech frequencies, for the production of tone frequencies (damped oscillations), for telegraphy by undamped oscillations, and a special artificial aerial for maintaining a constant load on the generator.**

The cores of the first two groups of radio frequency changers are saturated by one DC generator and the cores of the last group by a second DC generator indicated at B which is protected from radio frequency currents by the iron core chokes I, I. A regulating resistance R is included in series to adjust the magnetism of the cores of the last group.

Several methods of signaling are provided, for example, **telegraphy by damped oscillations** may be accomplished by the key K-4 shunting resistance R-3, or for the **production of tone frequencies** the key K-5 and buzzer B-2 are employed. For **speech transmission** the microphones M coupled to the audio frequency transformer P-7, S-8 are employed to vary the magnetism of the cores of the last group. **Telegraphy by undamped oscillations** again may be accomplished by the key K-2 which operates the relay R-2 and in case of high powers the keys K-1 and K-2 are operated in unison to prevent the development of disastrous voltages in the circuits. An artificial aerial is also provided to maintain a constant load on the generator, that is, the key K-3 may be closed and when key K-4 is operated for signaling, the generator output is automatically shifted from the antenna to the artificial aerial. The artificial antenna circuit includes the key K-3, winding S-6, variable inductance L-1, the load R, variable condenser C-1 and the winding S-5.

OPERATION

As usual the frequency of the alternator N, through the three steps of frequency transformation, is increased four times, that is, if the alternator frequency is 10,000 per second, the antenna current will be 80,000 per second.

The alternator circuit and the intermediate circuits of the frequency changers are tuned by the variable condensers and inductances as heretofore explained.

In case of low powers, telegraphy by undamped oscillations may be effected by closing the key K-2 which operates the relay R-2, the latter shunting a portion of the aerial tuning inductance to place the antenna system out of resonance with the alternator. The key K-1 shunting resistance R-1 is worked in unison with the key K-2 to prevent the development of high voltages in the radio frequency changers. Thus, when the antenna is detuned the sudden insertion of the resistance R-1 prevents the phase shifting of the current and voltage from generating disastrous voltages.

For large power outputs the key K-4 may be employed to saturate and de-saturate the yokes of the last group of radio frequency changers. For the production of damped oscillations a buzzer B-2 in series with the key K-5 shunts R-3 and the resulting changes of flux through the yokes is sufficient to modulate the antenna currents at audio frequencies. The radiated energy is then of the proper characteristic for reception by oscillation detectors suitable to damped oscillations only.

For **speech transmission,** the microphones M are connected to their source B-3 and the resulting changes of current are made to act upon the primary P-7 through the condensers C-7. The speech currents induced in S-8 vary the magnetization of the core sufficiently to modulate greatly the output or antenna current. Two microphones are connected in series and three such sets are connected in parallel. Each microphone group is shunted by winding P-7 of the telephone transformer and each branch includes one of the condensers C-7. The operation of the microphone control is as follows: Whenever microphone resistance increases, the current through its series resistance remains nearly constant, but the current through the microphone diminishes. The excess current therefrom flows through the primary winding P-7 and the corresponding condenser.

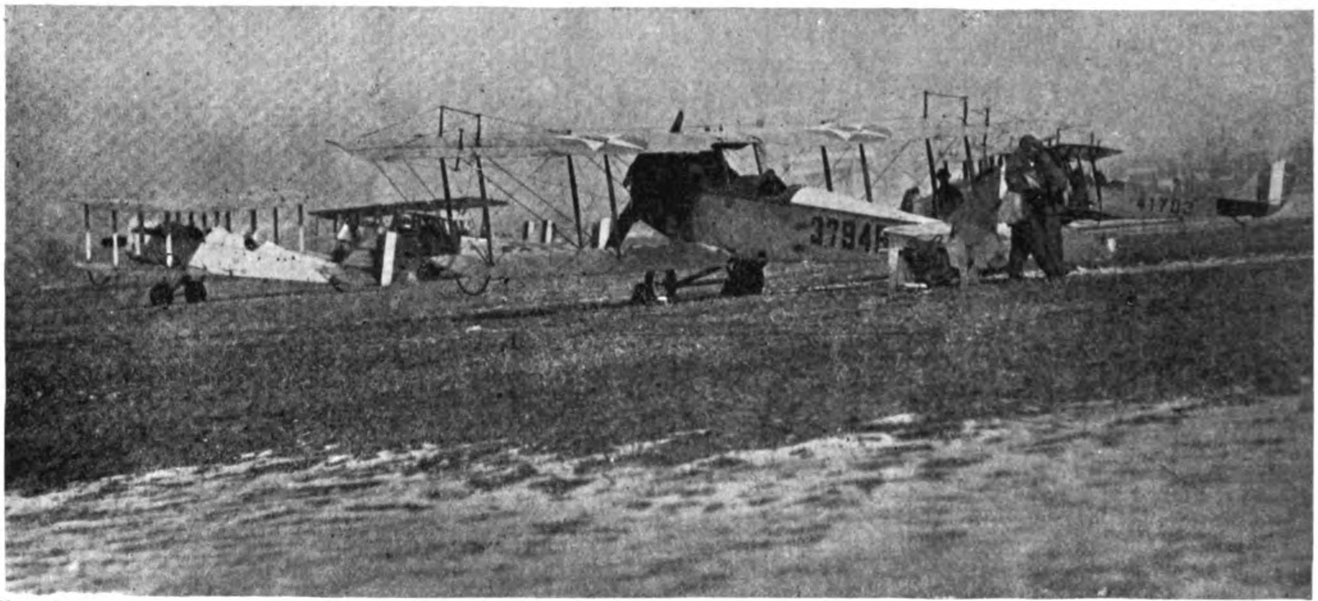

Photo Intern'l

Above: the finish of a coast to coast flight showing four U. S. Army airplanes which flew from San Diego, Cal., to Mineola, near New York City, for the purpose of mapping out a transcontinental aerial mail route; the distance covered was 4,200 miles in 53 flying hours

To the right: listeners of the British Navy using one of the inventions developed during the war which made possible the faculty of hearing the approach of submarines

Below: Capt. R. W. Schroeder, U. S. A., wearing the oxygen helmet necessary in making his altitude flight to 28,900 feet above sea level

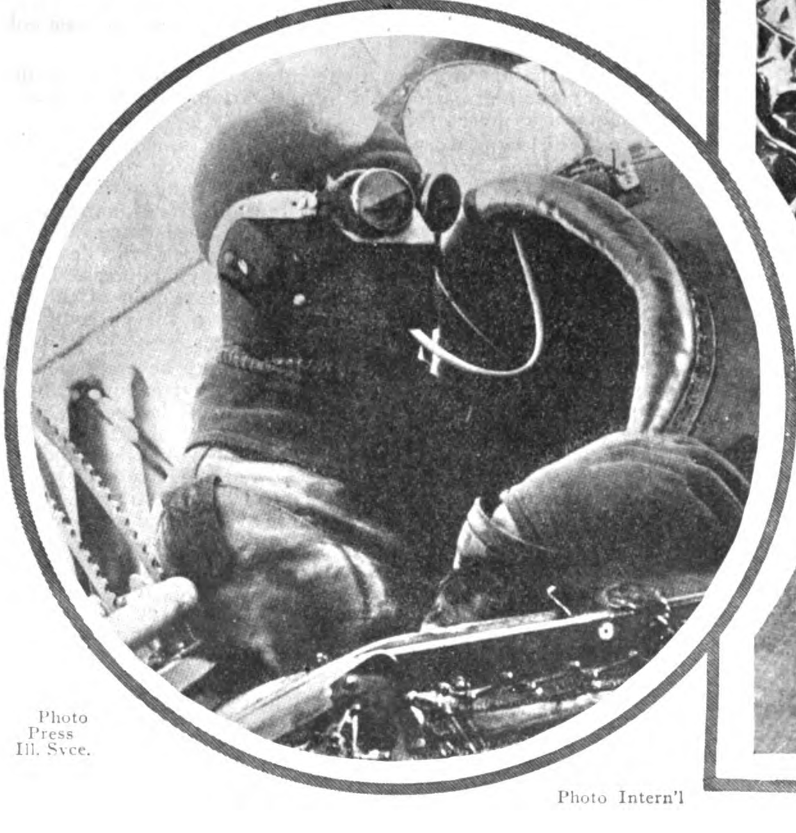

Photo
Press
Ill. Svce.

Photo Intern'l

The Monthly Service Bulletin of the
NATIONAL WIRELESS ASSOCIATION

Founded to promote the best interests of radio communication among wireless amateurs in America

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The Amateurs' Services Have Been Invaluable To Our Country

I SEE no reason whatsoever why the Government should not permit amateur stations to re-open immediately.

In modern warfare wireless plays an important part on land, water and air. One can say that it forms the nucleus of efficient warfare. Therefore, when war was declared by the United States against Germany, and the army and navy was put on a war basis, very many positions, requiring a knowledge of wireless telegraphy were automatically opened.

To teach men the rudiments of wireless telegraphy would require time. So the United States turned her gaze upon the many amateurs in the wireless telegraph field and called upon them to help her out of the predicament. The amateurs responded nobly to the call. Many of them have given the supreme sacrifice. But they were glad to give it for they gave it for the United States —the land of liberty and justice.

To fail to recognize the right of amateurs, earned by bloodshed and death, to immediately have their stations opened would make many fellows feel that their country, the land of freedom, was not treating them fairly and living up to its name. And this would be a calamity.

Why not open up the amateur stations and show that our Government realizes that the boys of the "dots and dashes" did their bit and did it *nobly*.

JOHN KULIK—*New Jersey.*

A Reason for Re-opening Amateur Stations

WITHOUT the help of some thousands of radio enthusiasts the task of efficiently training the necessary personnel to man our ships and furnish the Signal Corps with proficient radio operators or electricians would have been an impossibility, particularly if we consider the demand for men and the lack of facilities for their immediate training.

I can state emphatically from my own experience that the former radio amateur was more easily trained into a proficient operator than his running partner, the telegraph operator.

The help which was so quickly forthcoming from the radio amateur should be sufficient to convince the Government that to permit amateur stations to re-open, will in itself, constitute an indirect expression of their appreciation of the amateur's good services.

HENRY E. BARTON—*New York*

Plan for Organization Indorsed

To the Editor:

Mr. Batcher's plan in the February issue for organizing the amateur interests by states is a splendid idea, in fact it seems to present a great similarity to the plan I have in mind for the organization of amateurs of the state.

My plan would be to divide the state in about four sections, each section to have its board of directors and jurisdiction in that vicinity only; to have also a state board of directors, allow each district to furnish the necessary officers for the board, as President, Sec'y.-Treas., Corresp. Sec'y., and Publicity Sec'y.

If the state has four districts, the necessary officers for the state board of direction can be alternately furnished by each district. The state to have a national representative, this member to be chosen by the state council from amateurs within the state. Of course, to begin with, the organization must be incorporated within its state, also must have sufficient funds and working capital for bulletins, etc.

It seems to me that too many local bodies would be as much of a failure as having one too large, but I think that most any state organized into four districts would make in a majority of cases, a local body with lots of pep and stamina; but it may look too large, if one stops to consider that a number of towns do not possess any amateurs whatever.

Our one big blow! Can we find our Philanthropist of the art of radio science? Of course, some of the expenses can be met by dues from the membership, the exact amount being governed by the class of membership held.

I certainly agree with Mr. Batcher that amateur bodies must be formed, so as to be perfected on the resumption of the amateur privilege.

L. N. WAY, *Michigan.*

Why Not Recognize Our Constitutional Rights?

EVERYONE who is personally familiar with radio in all its phases, knows many reasons which would justify the re-opening of amateur stations upon the conclusion of peace. Among these are the services rendered by the so-called "amateurs" in the war, the development of radio resulting from investigation conducted by amateurs, the supply of radio operators for national defence in the future, the wholesome effect upon boys and young men exercised by the study of the art, the employment of capital and labor manufacturing apparatus, and many others.

These reasons have been often cited, and as I remarked above, any one of them would more than justify again opening the amateur stations, but these reasons are all based upon the insecure argument of expediency, while there is another that is more basic and rests upon the secure foundation of principle; it is that we live under a government "Of the people, by the people, and for the people"—nothing less.

Now if our principles as a nation recognized "Government of the people, by the Government," or "Government of the people by the Navy," the permanent closing of amateur radio stations might be legal and proper, but as we live under a government "of the people, by the people, and for the people," it is not, and the stations must therefore be re-opened.

In war, drastic powers are necessarily delegated to the various departments of the Government, but in peace it is different, and we should not for one moment forget that the army and navy exist only to defend the people and enforce their will, and not to rule them and devise regulations for their conduct. This is the first principle of our country, and should be indelibly stamped in the heart of every American.

All this being true, the most important reason why the amateur radio stations should be re-opened is because the amateurs *want* them re-opened, and have a *right* to have them re-opened.

JOHN V. PURSSELL—*Washington, D. C.*

The Fire Underwriters' Rules Applied to Amateur Stations

AMATEUR wireless apparatus often is not installed in accordance with the Underwriters' rules and in a few cases the violations are so serious that it constitutes a fire hazard. As a rule, radio amateurs are willing to adopt any changes which are suggested to them that will better their stations if it is within their means, but the conditions necessary for safe and satisfactory service from their power wiring, are only vaguely understood. It is the purpose of this article to point out the advisability of modifying the installation to conform to the Underwriters' rules, and the method of doing so. If the suggestions are acted upon, the fire risk will be materially reduced.

In many amateur stations the circuits supplying current for the high voltage transformer of the experimental radio transmitter are given little or no attention, and consequently the majority of stations are not as perfect as they might be in this respect. The wiring is sometimes installed in a slipshod fashion from a miscellaneous assortment of material that is unsuited for the purpose. Improper insulation of conductors from each other and surrounding objects, insufficient carrying capacity of conductors, absence of proper protective devices and overloading of circuits are the main shortcomings. It is not uncommon to find wiring that could hardly be considered of sufficient current carrying capacity for battery current, supplying a 1 kw. transformer and a rotary gap besides. The service rendered by such poor construction is usually very unsatisfactory, causing excessive drop in voltage at the transformer terminals, blinking of lights and other annoyances, not to mention the fire hazard sometimes incurred.

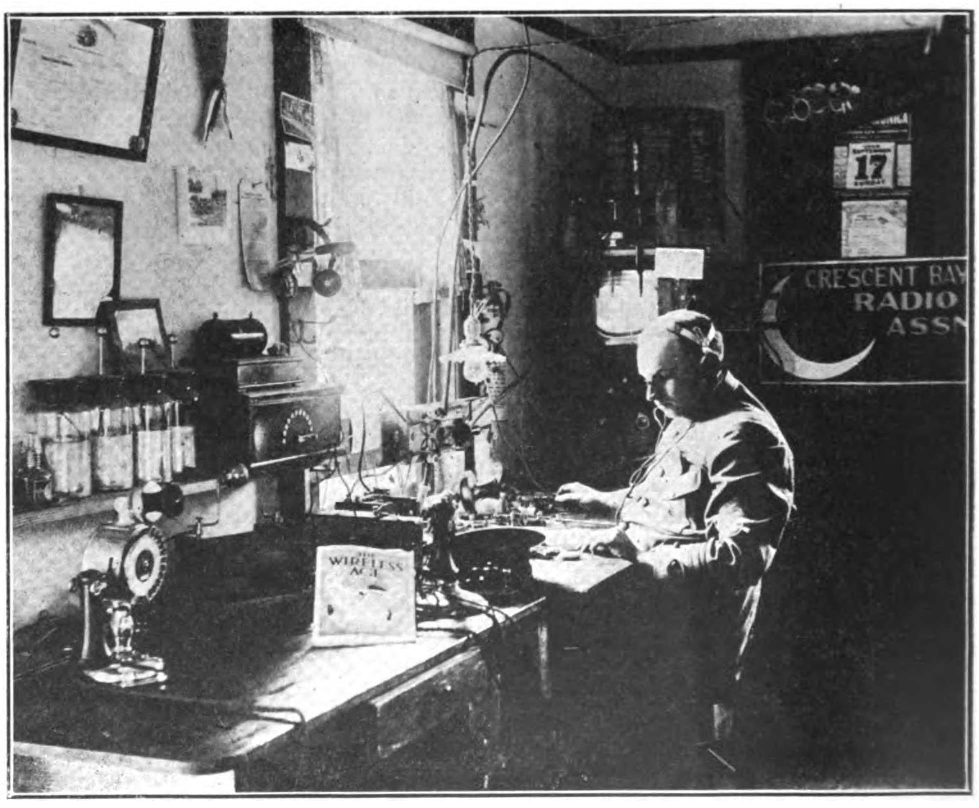
In planning the reconstruction of his station, the progressive experimenter should give this subject due consideration and take steps to remedy any defects that may exist in the circuits of his power supply. Of course the chief consideration regarding the installation is that it shall comply as nearly as possible with the rules of the Fire Underwriters, and if these conditions are met even half way a comparatively safe and satisfactory condition will obtain.

If your transformer is of 1 kw. it would be well to first ascertain whether or not the house meter has sufficient capacity to carry the full load plus that of the rotary gap and about half the house lighting load simultaneously. This precaution may save an extended argument with the power company or perhaps the price of a new meter. It is the general practice to install only a 5 ampere meter in residences, since they can stand a 100 per cent overload. It is always good policy to notify the electric company of your new load, and if they do not believe it to be necessary to change the meter, it becomes their risk and if the meter is burnt out it is their loss. I mention this because I had to "kill" two meters before the local electric company consented to installing one of increased capacity. No doubt other experimenters have had their troubles in this respect.

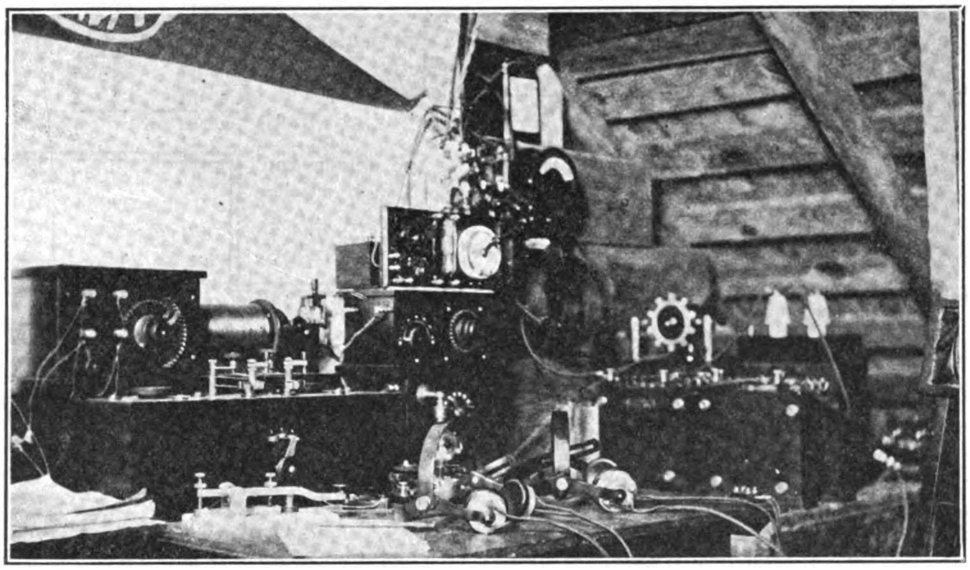
If the transformer is on an upper floor of the house, some distance from the meter, it is usually the practice to tap into a convenient fixture or base board receptacle, or else run a short feed which is tapped onto the lighting circuit wires at some point in the room. This should not be done since it is forbidden by the Fire Underwriters. The wiring of the average house is seldom larger than No. 14 B. & S. and in the fixtures it is usually No. 16 or No. 18 B. & S. The voltage at the transformer terminals will be low, and all lamps on that circuit or on the same feeding wires will flicker badly. Choke coils and other paraphernalia are usually resorted to in an effort to prevent this, but they can never be of great value so long as the current is taken from the fixtures. Furthermore no lighting circuit is supposed to carry more than 660 watts, so it is evident that the only method sanctioned by the Underwriters is to run a separate pair of feed wires of proper size to carry the current without excessive drop in voltage, from the meter direct to the transformer terminals. There should be an individual fuse block for these feed wires mounted either at the meter or else in the radio room where it would perhaps be handiest to replace a blown fuse without going down to the cellar while you tell the other fellow to stand by. This usually is done by the light of a candle, as the house lights are out as well.

It will be found a good investment to run separate feeds, as you have done the right thing by the Underwriters, the lights will not flicker and the lights in the house will not go out every time you blow a fuse. This will give the home folks a vastly better opinion of "wireless." The size of these feeds will be governed by several factors; the current in amperes taken by this transformer, the distance of the transformer from the meter, and the loss in volts that is permissible in carrying the current this distance. The formula for finding the size of wire is:— $d^2 = \frac{10.8LI}{e}$ and for finding the drop in volts is: $e = \frac{10.8\,L\,I}{d^2}$ in which d^2 is the area of wire in circular mils. 10.8 is a constant, "L" is the length of circuit in feet, "I" is the current in amperes, and "e" is the drop in volts.

We have, for example, a transform-



Station of the Crescent Bay Radio Association at Santa Monica, Cal., where consideration has been given to fire regulations



This station located near the Mexican border and belonging to D. H. Graham of House, Texas, could probably be improved by a more rigid observance of fire rules

er rated at 1 kw. located on the second floor of the house, and the meter is in the basement. First determine the path your wires will follow between the two points, then determine the length of wire necessary to follow this path one way. Let us say this is 75 feet. This sum doubled is substituted for "L" in the formula. Assuming that the current drawn by the transformer when operated at maximum load is about 10.5 amperes and that we have a rotary gap motor which takes 1.5 amperes, then the total load will be 12 amperes and this is substituted for "I." Now we must determine the permissible drop in potential for the value "e." The voltage at meter terminals is usually about 115 volts, sometimes a few volts higher or lower. As it is very desirable to have the voltage at the transformer terminals as high as possible, only a very small drop should be tolerated, not more than 2 volts at any rate. Suppose we use 2 volts for the value of "e." Substituting these values and solving we have $d^2 = \frac{10.8 \times 150 \times 12}{2}$ or $d^2 = 9.720$ circular mils. Referring to a table of wire dimensions we find that the size of wire which most nearly approaches our result is No. 10, and this should be used. Although this would satisfy conditions, it would be still better to keep the drop down to about 1 volt, and use a larger size of wire.

If it is desired to determine the drop in potential in an existing circuit the second formula may be used. A partial table of wire sizes covering those that are most likely to be used by the experimenter, together with those rules of the Fire Underwriters' from the 1919 code, class E, section 86, that deal with wireless telegraph apparatus, will be found at the end of this article.

In regard to the actual work of installing the feed lines; if you live in a town where it is necessary to have all electrical work done by licensed contractors, or if you do not feel capable of doing the work properly, it is best to have it done by an experienced wireman according to your specifications. If flexible armored cable is employed to protect the wires, it will conform to the Underwriters' rules and will be found very easy to install. It can be run either exposed or concealed under the floor and in partitions. The only thing that requires care is in stripping the armor to make connections, this being done by nicking it with a hack saw and bending back and forth until it breaks; then it can be slipped off. It is necessary to be very careful so that the wires or insulation will not be damaged. A condulet or other end fitting will be necessary at each end of the cable. Any wire supply store will gladly show you how to strip the cable and attach the fittings. The fuse block should be an ordinary two wire branch block for screw fuses, costing only a few cents. The new feeders should be tapped directly onto the wires from the meter that connect to the other fuse blocks for house lighting. While doing this the main switch should be opened so that these wires will be dead. All connections should be well soldered and taped. A ground wire of any kind of insulated wire of a size equal to that in the cable should be connected to the steel armor of the cable and then connected to a water pipe or other good ground. If these directions are closely followed, the radio experimenter of average ability should have no trouble in making a satisfactory installation, but he should make doubly sure that everything is O.K. by having an experienced man go over his work.

One other thing requiring attention is the provision of means to protect the house wiring from high potential surges or "kick back" from the transformer. There are a good many types of kick-back preventers; the electrolytic, needle gap, high resistance shunt of graphite rods, or large capacity condensers, etc. Probably the two best methods are the shunt condensers or the shunt resistance rods. Although the Underwriters' rules specify the condenser type of protection the high resistance shunt is used in commercial installations and is entirely satisfactory. In a future issue a full description will be given of a combined "kick-back" preventer and switch panel for experimental radio stations that is very neat and convenient and also not very difficult to construct. There are several types of this device on the market if one desires to purchase, instead of constructing it.

"Abstract from Regulations of the National Board of Fire Underwriters, Class E, Section 86, Wireless Telegraph Apparatus."

Note.—These rules do not apply to wireless telegraph apparatus installed on shipboard.

In setting up wireless telegraph apparatus (so called) all wiring pertaining thereto must conform to the general requirements of this code for the class of work installed and the following additional specifications:

a. Aerial supports to be constructed and installed in a strong and durable manner, and aerial conductors, with wires leading from same to ground switch, must be supported on approved insulators, and these conductors to be kept at a distance of not less than six inches from the building, except where entering same through approved non-combustible, non-absorptive insulators.

b. Aerial conductors to be permanently and effectively grounded at all times when station is not in operation by a conductor not smaller than No. 6 B. & S. gage copper wire run in as direct a line as possible to water pipe on the street side of all connections to said water pipe within the premises, or to some other equally satisfactory earth connection or to such other ground as may be allowed by special permission in writing.

c. Or the aerial to be permanently connected at all times to earth in the manner specified above, through a short-gap lightning arrester said arrester to have a gap of not over 0.015 inch between brass or copper plates not less than 2½ inches in length parallel to the gap and 1½ inches the other way, with a thickness of not less than one-eighth inch mounted upon non-combustible, non-absorptive insulating material of such dimensions as to give ample strength. Other approved arresters of equally low resistance and equally substantial construction may be used.

d. In cases where the aerial is grounded as specified in section b, the switch employed to join the aerial to the ground connection shall not be smaller than a standard 100 ampere knife switch.

e. Where supply is obtained direct from the street service the circuit must be installed in approved metal conduits or armored cable. In order to protect the supply system from high potential surges, there must be inserted in the circuit either a transformer having a ratio which will have a potential on the secondary leads not to exceed 550 volts, or two condensers in series across the line.

f. Transformers, voltage reducers or similar devices must be of approved type.

Wires for Interiors of Buildings
(National Code Standard)

		—Carrying Capacity—	
B. & S. Gauge Number	Circular Mils	Rubber-covered Wires Amperes	Weather-proof Wires Amperes
18	1,624	3	5
16	2,583	6	8
14	4,107	12	16
12	6,530	17	23
10	10,380	24	32
8	16,510	33	46
6	26,250	46	65
5	33,100	54	77
4	41,740	65	92

J. A. WEVER, *Maryland.*

EXPERIMENTERS' WORLD

EXPERIMENTERS are urged to submit manuscripts covering the design and construction of all types of wireless apparatus for amateur use. Such articles will receive immediate consideration and those published will be paid for at regular space rates. The scope of this department is constantly enlarging.

Technical Advice to the Experimenter

By E. T. Jones.

THE sketch, figure 1, gives the details of a mechanism for changing the secondary inductance of a receiving tuner from one tap to the next, which at the same time causes the shunt secondary variable condenser to rotate throughout its range of capacities before another secondary coil is connected into the circuit. The whole adjustment is brought about by the rotation of a single control handle. This arrangement eliminates the necessity for using both hands in changing the inductance and capacity while tuning and leaves one hand free for writing down the message.

The objects of my design are brought about by arranging the strips of brass 1, 2, 3, 4 and 5 of the end-turn switch figure 2, so that when coil No. 2 is cut in, the condenser has revolved from zero to maximum capacity, and so on throughout the series of taps. The condenser is rotated by attaching a pulley to the shaft of the end-turn switch and a smaller pulley on the shaft of the condenser. By a partial turn of the control handle the secondary variable condenser is shifted through its entire scale. It is clear to the reader that a certain relation must exist between the diameter of the pulley on the condenser and that on the main shaft; also the taps on the secondary inductance must be of sufficient width to permit the variable condenser to rotate over its scale before the switch reaches the next contact point.

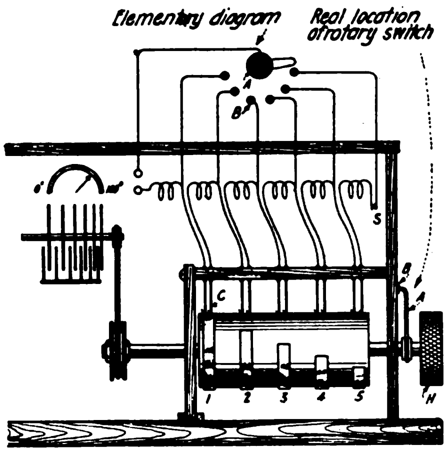


Figure 1—Detailed sketch of mechanism for changing the secondary inductance of a receiving tuner

The switch A, B, is of the rotary type and connects each coil in the circuit only when the last end is brought into the circuit by the end-turn switch. The rotary type of switch is necessary because the contact must be maintained while the switch is rotating and it should only make connection with the next strip in the circle when additional inductance is desired.

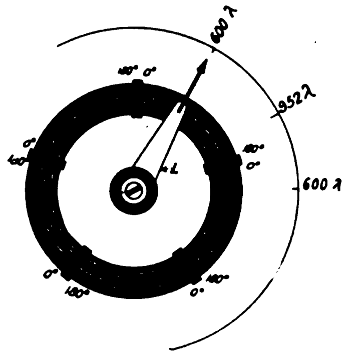


Figure 2—Rotary switch used to connect the coils

In figure 1 the location of the switch is indicated at the lower right hand part of the drawing and an elementary diagram of connections at the upper part showing how the coils are connected in the circuit.

The rotary switch to be used in conjunction with this aparatus is shown in figure 2 where a contact lever coil makes connection with copper segments 1, 2, 3, 4 and 5. These may be made of brass if desired.

The diameter of the switch must be chosen so that an individual segment will be long enough to permit the variable condenser to be rotated over its scale while the blade is on one tap.

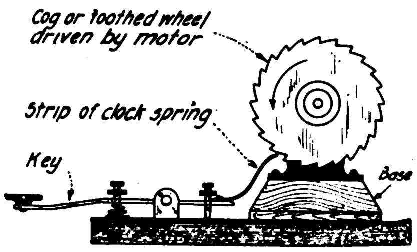


Figure 3—Mechanical code practice device

The experimenter will observe that as the inductance switch leaves one tap and makes connection with the second tap, the wave length at the first part of the scale of the second tap will be shorter than the maximum wave length of the preceding tap. But as the switch is moved on and the variable condenser is rotated over the scale, the longest wave will be considerably in excess of the wave obtained from the preceding coil.

As indicated in the drawing a wave length scale may be attached to the inductance switch, to indicate the wave length of the secondary circuit for various positions of the shunt variable condenser.

Code Practice Device

A very serviceable set for use in code practice is shown in figure 3. The object of it is to generate a buzzing signal without the use of a buzzer.

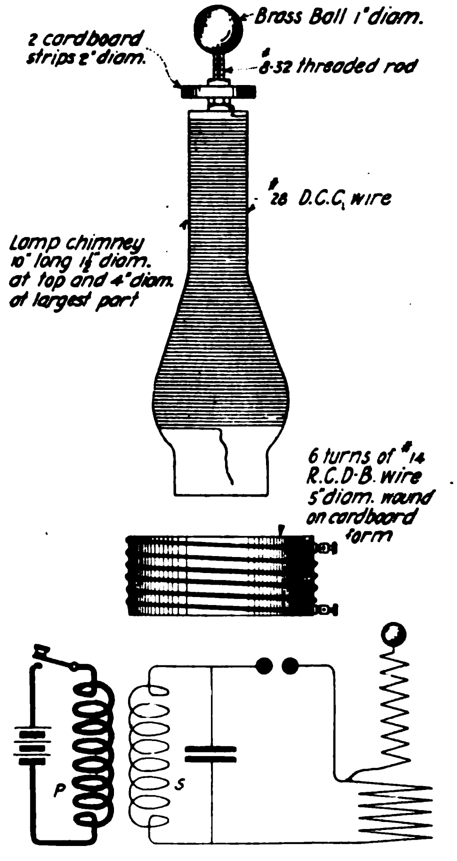

Brass Ball 1" diam.
2 cardboard strips 2" diam.
#8-32 threaded rod
#28 D.C.C. wire
Lamp chimney 10" long 1½" diam. at top and 4" diam. at largest part
6 turns of #14 R.C.D.B. wire 5" diam. wound on cardboard form
P
S

Figure 4—Diagram of detailed construction of the Oudin resonator

The telephone current is interrupted by a cog wheel which may be taken from an old clock.

No current is utilized other than that which turns the motor to which is attached a toothed or cogged wheel. The key is situated so that upon pressing same it raises a strip of clock spring which barely touches the revolving cog wheel. This produces a very clear note when adjusted correctly. The motor should rotate away from the operator to protect his eyes from the flying filings which are liable to be thrown from the steel spring or the brass or iron cog wheel.

A very precise adjustment can be arrived at by making tight all screws on the key after adjustment, the spring being arranged to barely touch the wheel in order to preserve its life. This, as a whole makes a very cheap practice set giving loud signals. A small Ajax motor and a cog wheel 4 inches in diameter by 1/8 inch thick, connected in series with four good dry cells, gives good results.

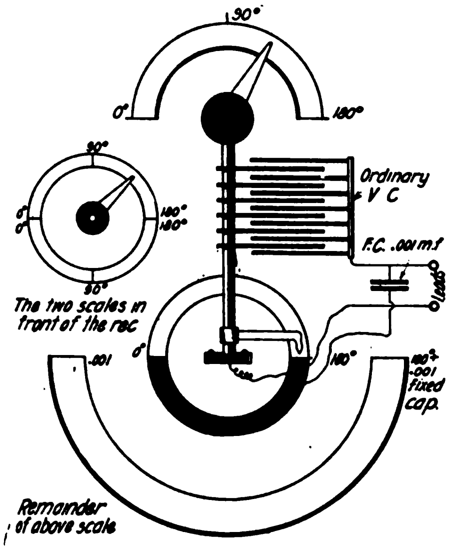


Figure 5—Sketch of a fixed condenser and variable condenser combined by means of a special switch to double the capacity

A pulsating note of a frequency depending upon the number of teeth on the wheel and the speed at which it rotates is obtained.

A Small Oudin Resonator

The Oudin resonator in figure 4 will give a good three inch spark with a 1/2 to 3/4 inch spark coil.

The secondary circuit is wound on a lamp chimney, making an excellent insulator. To place the wire, start from the end with the smallest diameter and wind upwards. It is impossible to wind from the other end owing to the slope of the chimney, but it is an easy matter to wind the opposite way. A globe ten inches long is covered with No. 28 D.C.C. wire closely wound (not spaced) 1/2 inch from the top and 2 1/2 inches from the bottom as shown. The primary is composed of 6 turns of No. 14 R.C.D. B. copper wire spaced about 1/2 inch apart, wound on a cardboard form 5 inches in diameter. The connections are shown just below the constructional drawing. This type of resonator will be found to be of exceptional interest and can be constructed at a small initial expense.

All kinds of high frequency phenomena can be demonstrated such as drawing sparks to your hand or to an iron instrument in your hand. Standing on an insulated form, matches can be lit from any part of your body by some one standing on the ground. Drop a piece of tinfoil inside the globe and a great quantity of ozone, a great germ killer and sure cure for colds, etc., will be generated and can be inhaled from the top of the globe.

Stand another small coil such as the primary or secondary of a "loose coupler" about 6 inches away from the resonator when in operation and without any connection whatsoever, a spark will appear at both ends of the winding, the forerunner of the wireless transmission of power. Hang a small light or lamp into the globe and a beautiful blue light will fill the globe. By bringing a piece of glass say 1/8 inch thick close to the ball and a piece of wire held in the hand close to the other side, the current will jump from the ball to the wire as if the glass were not there. The field for experimenting is great, and it is my personal opinion that if it ever becomes possible to intercept such waves that the whole world could be communicated with by the use of a small oudin coil. The frequency of the currents being generated are so great that they are absolutely inaudible—but who can tell what will take place in this wonderful new field in a space of ten years.

Means for Doubling the Capacity of a Variable Condenser

The combination of a fixed condenser, a variable condenser, and special switch, as in figure 5 will double its range of capacity.

It is clear from the diagram that when the ordinary condenser is at 180 degrees the maximum amount of capacity is in use, but if the condenser is brought back to zero and rotated toward the left instead of toward the right, a fixed condenser having the same amount of capacity as the variable condenser at maximum is connected in parallel. Therefore by rotating the condenser in the opposite direction, we can progressively double its capacity in the same manner as it is built up to its maximum capacity in the ordinary way. The scale on the outside of the condenser will be a complete circle instead of the usual half circle, or 180 degrees. An insulated circle is provided and half of it is made conductive by means of a strip of brass which cuts in the other fixed condenser. A switch arm protrudes from the shaft of the condenser and makes contact with the switch (brass semi-circle) cutting in the extra capacity.

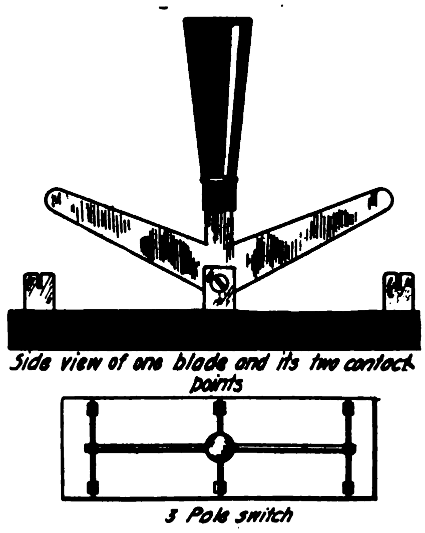


Figure 6—Sketch of switch used for starting small A. C. motors

This is a very convenient arrangement and is easily added to the ordinary receiver.

Special Switch for Starting Small A. C. Motors

Ordinary types of switches furnished for this purpose are of the three pole double throw type, reactance coils being thrown in on one side in the motor line circuit and the other side cutting in the full line voltage. This is an awkward arrangement owing to the fact that one is liable to throw his arm across the line when pulling the switch from one position to the other in a hurry. For that reason, I have constructed the switch shown in figure 6. It works on the rocking principle, passing through an arc of about 25 degrees, thereby making it much easier to shift the connections.

Suggestion for Prize Contest APRIL Wireless Age

We will pay the usual prizes of $10, $5 and $3, in addition to our regular space rates, to the three contributors who send us the best manuscripts on the following subject:

Give arguments for or against the use of a quenched spark gap in connection with an amateur's 60-cycle transmitter.

The Vacuum Tube Generator for the Radio Laboratory

A VACUUM VALVE connected up as a high frequency generator and mounted with auxiliary instruments will be found a very useful piece of apparatus around an experimental radio laboratory. It may be employed in several ways such as calibrating wave meters, inductances, condensers, measuring the decrement of decremeters and high frequency resistance; also as a source of radio frequency oscillations for beat reception and in many other ways.

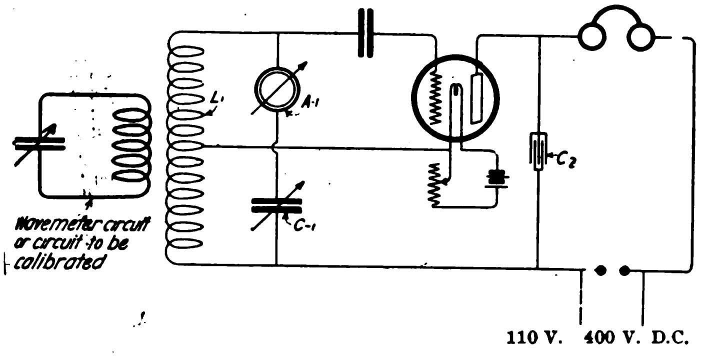


Figure 1—A simple circuit having a vacuum valve connected up as a high frequency generator

The amount of energy obtained from such a device will, of course, depend upon the size of the valve, its operating characteristics, and upon the E. M. F. of the plate battery. One hundred and ten to 250 volts D. C. can be safely applied to most bulbs, and in some cases more, without undue heating of the grid and plate, but it is best to consult the manufacturer of the tube for potentials above 250 volts.

Several circuits may be employed. That shown in figure 1 is very simple and will do the work of more complicated connections.

The size of the coil L_1 and condenser C_1 will depend upon the range of frequencies desired. It will be found that if a variable condenser C_1 having a maximum capacity of .0005 mfd. is used, the coil described below will be correct for a frequency of 120,000 cycles or above, which corresponds to the wave length of 2,500 meters at the maximum value. The coil should consist of a single layer of No. 26 S. C. C. wire wound on a tube 4 inches in diameter and 4 inches long. One hundred and seventy-five turns will be necessary, which will occupy a winding length of 3.5 inches. With a condenser C, having a capacity .005 mfd., 50 turns of the same wire, on the same sized cylinder with a winding length one inch long are needed. Three taps should be brought out from the coil, one at each end and one in the center.

The circuit should be calibrated against a standard wave meter. The distributed capacity of the coil, the effect of the leads and of the internal capacity of the bulb itself will change any theoretical determinations of the oscillation constant. A hot wire ammeter A_1 will indicate when the tube is oscillating properly. It should have a range of not over .5 amperes maximum except when large bulbs and high voltages are used. The condenser C_2 should have a capacity of 2 mfd. The telephone receivers and the grid condenser should both have a short circuiting switch or plug to cut them out of the circuit when they are not in use.

The whole apparatus should be mounted on one base or in a case with the inductance L_1 in such a position that it may be readily placed near another circuit.

To calibrate a wave meter with this apparatus place the inductance coil of the wave meter to be tested near the coil L_1 as indicated in the diagram, and set the condenser of this wave meter at some desired point. Note the reading of the ammeter A_1 in the oscillating circuit. By varying the condenser C-1 it will be found that as the condition of resonance between the two circuits is reached the current indicated by A_1 will fall off, often dropping to zero if the coupling between the two circuits is close. When the resonance point is passed the ammeter will again read the normal value. It is necessary to note the point on the condenser C_1 when the current in A_1 is at a minimum, and refer to the calibration curve for the circuit L_1, C_1 to find the wave length at this point. It is not necessary to have the two circuits coupled so tightly that the current in A_1, drops to zero, as a slight decrease is all that is necessary. Otherwise two waves will be in evidence if the coupling is too tight.

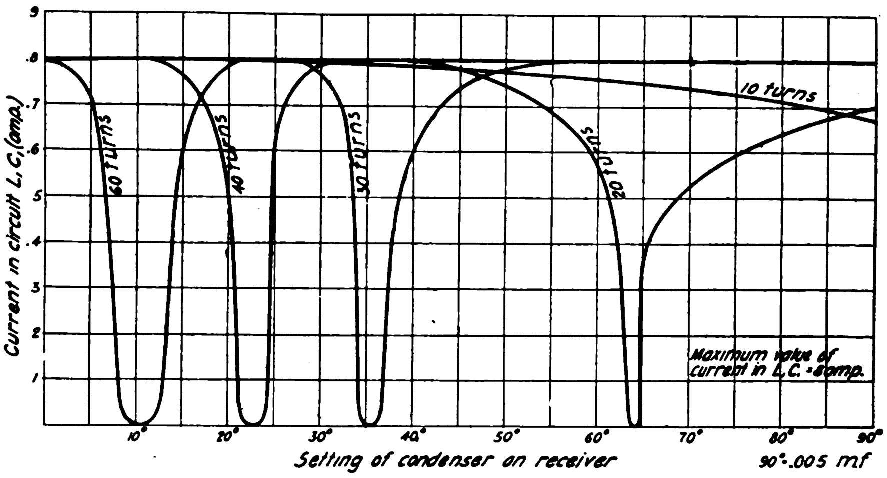


Figure 2—Graphic curves taken while calibrating a receiving set

The advantage of this method is that no connections need be made to the wave meter under test. It is a very rapid method of making a calibration. It is understood that with the standard condensers and inductances on hand the calibration of coils and condensers may be done in the same manner.

Curves taken while calibrating a receiving set are shown in figure 2. These show distinctly how the energy is "drained" from the valve circuit when resonance between the two circuits is reached. In these determinations the frequency of L_1C_1 was left constant and the condenser of the receiving set was varied, its values forming the abscissa on the curve sheet. Each curve represents one value of inductance on the receiving transformer.

There is another method in which a very interesting phenomena is made use of. It will be found that under certain conditions that a beat note will be heard in the telephones when the circuit L_1C_1 is nearly in resonance with the wave meter circuit. A shrill note is first heard as C_1 is rotated which drops to a low tone and then rises to inaudibility as the resonance point is passed. Anyone who is acquainted with beats will easily recognize the point when resonance occurs. It is necessary to have a correct value of the grid condenser, and sometimes a grid leak in order to have this action occur. An explanation of the theory of this action will be found in an article by Prof. L. A. Hazeltine, in the Proceedings of the Institute of Radio Engineers for April, 1918, on page 76.

The telephone receivers and the grid condenser are not needed for other tests and may be omitted, if desired.

Ralph R. Batcher, *New York.*

A Small Radiophone Transmitter for the Amateur Station

LOW powered radio telephone transmitters soon will be the order of the day, but few amateurs know just exactly how to get started in this branch of radio. The books "Radio Telephony" by Goldsmith and "Vacuum Tubes in Wireless Communication" by Bucher, are excellent for obtaining an understanding of the operating characteristics of continuous wave generators for speech transmission. This article aims only to give constructional details.

Directions for assembling a small radio telephone, which should have a transmitting range of at least six miles, follow. Prior to the war, a similar but cruder set was constructed, using but one ordinary vacuum tube with a speaking range of three miles.

In constructing a radio telephone, there are three primary obstacles which confront the experimenter. He must find:

(1) A very simple and easily understood hookup, containing inexpensive and easily procured instruments.

(2) A source of direct current of fairly high voltage.

(3.) A continuous wave generator.

The three element vacuum tube will be the only type considered. Figure 1 gives a hook-up which seems an adequate answer to problem (1).

If the amateur has access to a source of 110 volt AC and a sufficient amount of money to expend, he may either obtain a 500 volt DC motor generator or a Kenotron rectifier, patterned after the Fleming valve, and obtainable from the General Electric Company. Either the DC generator or the Kenotron with 500 volts AC, may be employed to supply the plate current. With such sources of current, quite a respectable transmitting range may be obtained. However, few amateurs will care to begin their radiophone experiments on such a large scale. The experimental set herein described uses from fifty to ninety volts of the large size tubular flashlight batteries or No. 6 dry cells. In wholesale lots the price is not as high as one might imagine from retail comparison. Under favorable circumstances a discount as high as 50 per cent may be had on quantity lots.

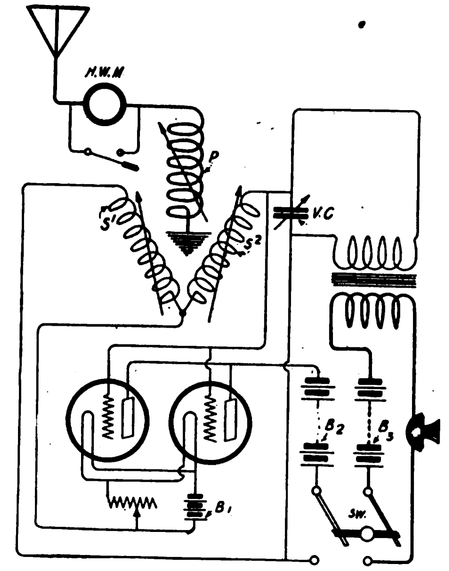


Figure 1—Hook-up of instruments for a small amateur radiophone transmitter

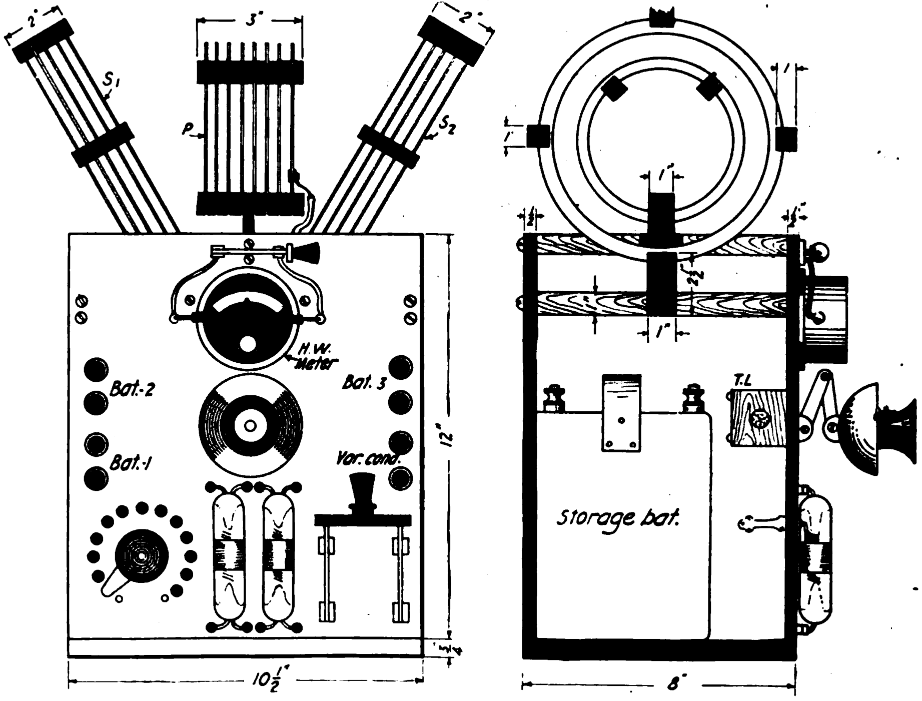


Figure 2—Front and side view of assembled radiophone transmitter

Problem 3 as in problem 2 resolves itself into a question of financial resources. The continuous wave generator in the outfit described here consists of two small, three element vacuum tubes such as tubular bulbs or electron relays with the members connected in parallel. Additional bulbs may be added to increase the range, which should be from two to six miles per bulb, depending on the tuning of the circuit and the efficiency of the antenna and ground.

After the experimenter has gained a working knowledge of radio telephony and has access to a source of high voltage, he should get possession of a "power bulb" such as the Pliotron or one of the Marconi bulbs. Large bulbs of this type, fed by 500 volts DC often given a speaking range of a hundred miles or more.

Figure 2 gives the front and side view of the assembled outfit. The front panel should be made of some good insulating material such as Bakelite. The base and back may be of hard wood treated with asphaltum varnish or a mixture of lamp-black and shellac as they are touched by no current carrying connections. On each side of the panel, about 9 inches up from base, two wooden strips 7 inches long should be placed between the back and front, to strengthen the construction. These are not shown in the side view as they would cover up the wooden, inch square strips which support the two secondaries. These hinge from the primary with these strips as axes.

Each of the two secondaries, S_1 and S_2, is composed of five turns of edgewise wound copper strip spiral 7½ inches in diameter, ½ inch wide and 1/16 inch thick. Each turn is held ⅜ inch apart from the adjoining turn by strips of Bakelite, 1 inch square and 2 inches long, except at the bottom. The coil is fastened to the axis upon which the secondary pivots by a piece of Bakelite shaped as in figure 3-A. The primary, P, is composed of copper, spiral wound edgewise as the secondaries and is 5 inches in diameter, 5/16 inch wide and 1/16 inch thick. Each adjoining turn is held ⅜ inch apart by Bakelite strips, ¾ inch square and 5 inches long, except at the bottom, where the primary is supported by a piece of Bakelite as in figure 3-B. This piece is to be fastened to a strip of wood, held between the front and back panels by wood-screws as in the side view of figure 2. The copper strip for the "oscillation transformer" may be purchased from wireless supply houses.

The transformer is designed considerably heavier than necessary for the current derived from the high voltage battery as suggested here, for the experimenter sooner or later may find himself in a position to use power bulbs and a commercial form of high voltage supply.

In most radiophone circuits a radiation indicator (such as a hot-wire ammeter) is essential, for successful operation depends mainly on careful tuning. The meter suggested is one of the small "junior" patterns. It should be short circuited by the switch at top of panel when not in use.

The battery B_3 in the transmitter circuit may be from six to ten volts of storage or No. 6 dry cells. The transmitter is taken from one of the common long-distance telephones. If it happens that the carbon grains become fused, replace them with larger grains. The induction coil I is nothing more than the ordinary telephone transformer. A type that will operate from a ten volt dry battery may be purchased from any electrical supply house. Both the high voltage battery B_2 and battery B_3 are cut into the circuit by the switch at the bottom of the panel. One rated at 30 amperes, 250 volts is about the right size to use.

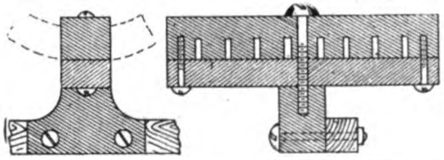


Figure 3A—Detail of fastening coils

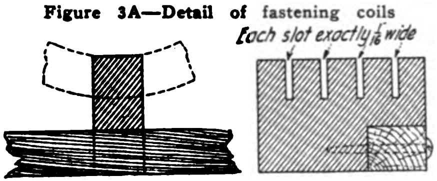


Figure 3B—Primary supported by a piece of Bakelite

Battery B_1 is a six volt storage battery and is mounted behind the panel to prevent the outfit from overturning. The filament rheostat in the lower left hand corner of the panel is made in accordance with my article in the November 1918 Wireless Age. There are sixteen points of variation of one-half ohm each. A good radius for the switch points is 1½ inches.

Better results will be obtained if the bulbs are purchased from a reliable company which standardizes its products, that is, all bulbs are supposed to be alike.

The variable condenser VC is one of the 43 plate receiving type, filled with castor oil, or a good grade of motor oil to give a capacity of .005 mfd.

The design of the three coupling coils herein described permits a range of 180 to 350 meters with the average antenna. If permission can be obtained to use a longer wave length, either a loading coil or a longer aerial may be used, of which, the latter is preferable.

The variation for the high voltage battery is obtained by a clip and flexible lead at the battery box as it would be impractical to take a large number of leads up to the panel from the batteries.

It is of even more importance in radio telephony than in wireless telegraphy that the various leads and connections should be of litzendraht or stranded wire, and well soldered. No. 12 rubber covered stranded wire, is a practical size for the outfit described.

It would be a great benefit to experimenters if some genius for organizing would start a "National Amateur Radiophone Service League," modeled on the same general plan as some of our present relay organizations.

Think it over fellows, and send in your suggestions to The Wireless Age. Francis R. Pray—*Mass.*

Design of a Self-Cooled, Quenched Spark Gap

Assume that the amateur desires to construct a quenched spark set to fit a 1 kw. 500 cycle transmitting set, so that the gap will be self-cooling. Also assume an 11,300 volt transformer and a condenser capacity of .008 mfd., experience teaches that the gap current will be about 18 amperes. This is the root mean square and must be mutiplied by $\sqrt{2}$ or 1.4 to obtain the maximum value, namely 18x1.4=25.2 amperes. In the design of quenched spark gaps, one square inch of surface should be allowed for every 10 amperes of current. Gaps of smaller dimensions will cause arcing, and plates of excessive size will cause a ragged spark tone.

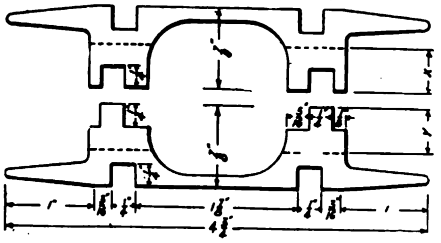


Figure 1—Showing design of spark gap

In the particular example cited, 25÷10 gives 2.5 square inches as the area of the gap, keeping in mind that diameter $= \sqrt{\frac{\text{area}}{.7854}}$; and in this example $\sqrt{\frac{2.5}{.7854}}=1.8$ inches approximately. We must now allow 10 mils separation between the plates and a potential difference of 1,000 volts per gap; also we must allow .25 inches between the silver and the rim. If the rim is 3/16 of an inch in width, the total area of the rim will be approximately 1.4 square inches. We may now allow for the gap losses, 15 per cent. of the power, which in this case equals 150 watts; and since for a potential difference of 1,000 volts we must have 11 gaps, we must allow 150÷11=13.6 watts to be dissipated per gap. Then assuming .2 watts per square inch for a 50° C. rise of temperature for continuous working, we have 13.6÷.2=68 square inches, the surface required.

If we employ 2 cooling vanes per gap, then the approximate area will be equal to 68÷4 (the number of sides of two vanes)=17. The over-all diameter $= \sqrt{\frac{17}{.7854}}=4.7$.

It is now assumed that the completed gap is mounted in a metal frame and that the plates are pressed tightly together by means of a threaded bolt. We may then determine the leverage ratio with a 13 thread screw bolt and a 6 inch wrench; that is, ratio $= 2\pi$ 6x13 threads x 1 lb. = 489.84, or approximately 490. If we allow 150 lbs. per square inch to make up for the tightness required with mica gaskets, we have 150x1.4 (area of rim)=210 lbs. Figuring $\frac{210}{490}$ gives about ½ lb. pressure to be placed on the end of a 6 inch wrench.

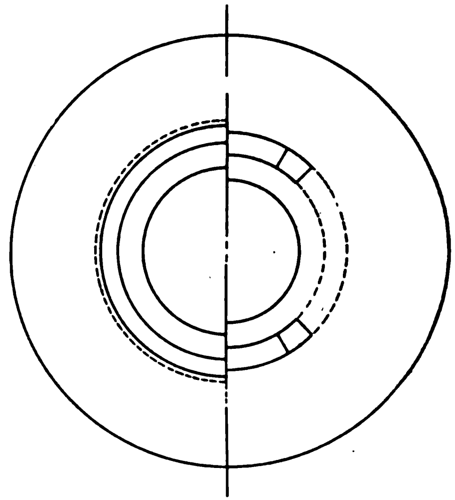


Figure 2—Gasket plates

The sections marked X and Y of figure 1 are cut away to a depth of ½ inch for a space slightly less than ¼ circumference of the circle, so that when the gaps are put together the air can circulate through the main body of the gap.

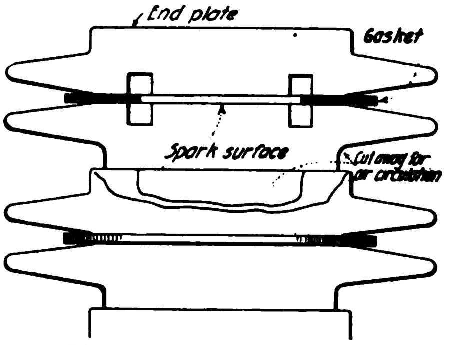


Figure 3—Spark surface of plate

Figure 2 shows the plates of the gasket and figure 3 the sparking surface of a particular plate. It also shows a portion cut away for air circulation. If the gap is to be used intermittently, allow .4 watt cooling surface for a 50°C. rise in temperature.

J. J. Holahan, *Virginia.*

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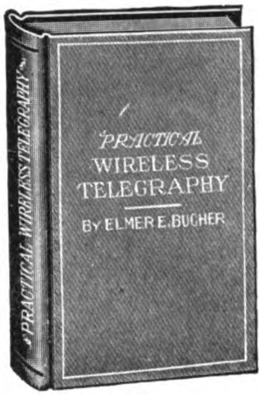

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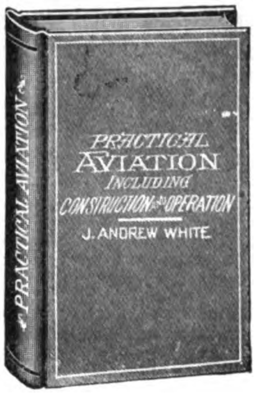

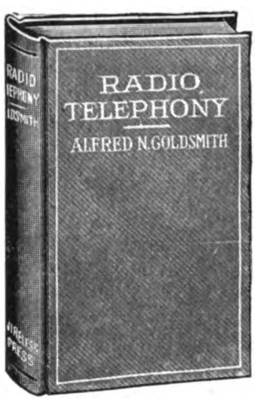

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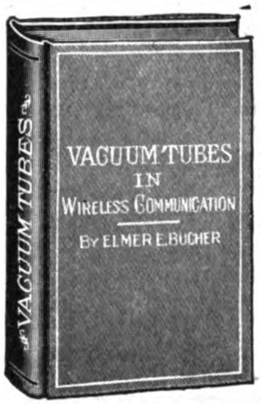

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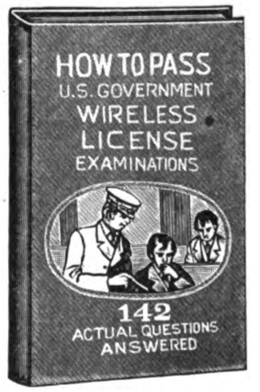
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Finding the Distance Between Wireless Stations

THERE is only one practical method of accurately finding the distance between any two points on the earth's surface, such as two wireless stations, and that is by means of spherical trigonometry. Recourse is had to this method in navigation, astronomy, and other scientific pursuits; also, maps are plotted from certain calculations obtained in this way. All maps based on Mercator's projection become increasingly inaccurate as the poles are approached, and hence are of no value in finding distances near the poles, or those which span any great part of the earth's circumference.

The actual details connected with the method herein described are usually taught in advanced trigonometry classes in colleges, but since only a few formulas are needed, along with a table of the various trigonometric functions, it is presented in the hope that those who have not had the advantage of such training, or else have forgotten the work, may avail themselves of the method. The use of the tables does not necessarily require a knowledge of trigonometry, but a working knowledge of common logarithms will greatly simplify the labor incident to these calculations.

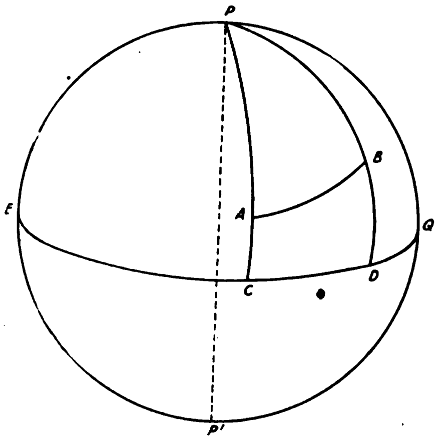


Figure 1—Diagram showing method of determining the distance between two wireless stations

The tables should give the values of the sine, cosine, tangent, and cotangent to within 10'. Greater accuracy is not required, as it is usually impossible to obtain the latitude and longitude with much more exactitude than this, and since 1' is only equal to 1.1516 miles, the error is inappreciable.

To apply this method, it is only necessary to know the latitude and longitude of each of the two places concerned, which can be found on any map, and by use of the formulas which will follow, the distance between them can readily be found. A brief discussion, however, will be of value to anyone making use of these formulas. In figure 1 is depicted the earth's globe, P and P' representing the poles, EQ the equator, and A and B any two points on the earth's surface whose separation it is desired to find. It is evident that AC is the latitude of A, BD the latitude of B. By substracting each of these values from 90 degrees we will obtain AP and BP respectively, the two known sides of the spherical triangle ABP. It is to be noted that these values are in degrees and minutes, as in the case of spherical triangles the sides are given as parts of an arc or a circumference.

Also, A has a given longitude, and B has a given longitude, and the difference between these two values will be the separation of A and B in degrees of longitude along the equator, or, the value of the angle APB. In case either A or B are on opposite sides of the prime meridian, or of the 180th meridian, a different procedure must be followed, as is explained later.

We have now determined the two sides AP and BP, and the included angle APB, of the spherical triangle ABP. For the sake of convenience, we shall refer to the angles shown by the capital letters which designate those extremities, as angles A, B and P. The sides of the triangle shall be referred to as AP, BP, and AB, the latter being the unknown side whose length we are to find.

The following formulas are then applicable, the first two being Napier's Analogies:

$$\text{Tangent } \tfrac{1}{2}(A+B) = \frac{\cos \tfrac{1}{2}(BP-AP)}{\cos \tfrac{1}{2}(BP+AP)} \cot \tfrac{1}{2} P$$

$$\text{Tangent } \tfrac{1}{2}(A-B) = \frac{\sin \tfrac{1}{2}(BP-AP)}{\sin \tfrac{1}{2}(BP+AP)} \cot \tfrac{1}{2} P$$

Also, $\tan \tfrac{1}{2}(A+B) + \tan \tfrac{1}{2}(A-B) =$ greater unknown angle, and $\tan \tfrac{1}{2}(A+B) - \tan \tfrac{1}{2}(A-B) =$ smaller unknown angle. Which angle is A and which is B can be found by applying the rule from geometry, that the greater angle is opposite the greater side, and vice versa.

Having found the unknown angles A and B of our triangle, we now apply the law of Sines in spherical triangles, namely:

$$\sin AB = \frac{\sin P}{\sin B} \sin AP$$

Looking up the value for the anti-sine of AB, gives the distance between these two points in degrees and minutes. This value (in degrees and decimals of a degree) is then multiplied by 69.117 to obtain the distance in statute miles.

Let us now examine the results of an actual calculation to fully fix in our mind the use of these formulas. Supposing it is desired to find the distance from Arlington, Va., to Kahuku, Hawaii. The latitude and longitude of the former are 38° 50′ N., 77° W., respectively; of the latter, 21° 40′ N., 158° W. Subtracting the two latitudes from 90°, we have 51° 10′, and 68° 20′ for the sides BP and AP of the triangle, respectively. Also, the angle P, being equal to the difference in longitude of the two places, is $158° - 77° = 81°$. Applying the formulas:

$$\tan \tfrac{1}{2}(A+B) = \frac{\cos \frac{1}{2}\ 17°\ 10'}{\cos \frac{1}{2}\ 119°\ 30'}\ \cot \tfrac{1}{2}\ 81° = 2.298$$

$$\tan \tfrac{1}{2}(A-B) = \frac{\sin \frac{1}{2}\ 17°\ 10'}{\sin \frac{1}{2}\ 119°\ 30'}\ \cot \tfrac{1}{2}\ 81° = 0.2023$$

Looking up these values, we have, $\tan \frac{1}{2}(A+B) = \tan 66°\ 30'$, and $\tan \frac{1}{2}(A-B) = \tan 11°\ 26'$. Therefore, applying our rule for finding the unknown angles, and noting that the angle at Arlington is the larger of the two, we have:

$$\text{Angle } A = 66°\ 30' - 11°\ 26' = 55°\ 4'$$

and

$$\text{angle } B = 66°\ 30' + 11°\ 26' = 77°\ 56'$$

Also, we have

$$\sin AB = \frac{\sin 81°}{\sin 77°\ 56'}\ \sin 68°\ 20' = 0.9386$$

From which $AB = 69°\ 50'$, or 69.8°. This is then multiplied by 69.117, giving the value 4825 statute miles as the distance between Arlington and Kahuku.

It has been stated that in case the stations are located on opposite sides of the prime meridian, or of the 180th meridian, a different procedure is necessary for finding the angle P. In the first case just mentioned, the longitudes are added instead of substracted, in the second case both values are subtracted from 180° and the results added together. A little consideration will show the necessity of such methods.

In case the two points are almost of the same latitude, a simpler method will give the same results. It consists in finding the difference in longitude of the two places, and multiplying this by the value of a degree longitude in miles, at the mean latitude. For example, Funabashi, Japan, is at latitude 35° 40′ N., and Los Angeles, California, is at latitude 34° N. The mean latitude is 34° 50′, and at this latitude a degree is equal to 56.95 miles. Hence the distance is equal to 101.67° (the difference in longitude) times $56.95 = 5790$ miles. Tables of this sort are called spheroidal tables, giving the length of a degree longitude at various values of latitude, in nautical and statute miles. The student is referred to the Year Book of Wireless Telegraphy for the complete values.

Hints for the Experimenter's Workshop

YOUR readers may be interested in the method, shown in figure 1, for making rods for zinc spark gaps. An iron pipe is sawed lengthwise as in A to constitute the mould. The zinc cases of old dried batteries are melted and poured in as shown. In the same manner points for rotary gaps can be made. A threaded bolt should be moulded in place in the process so that the points can be screwed to the rotor.

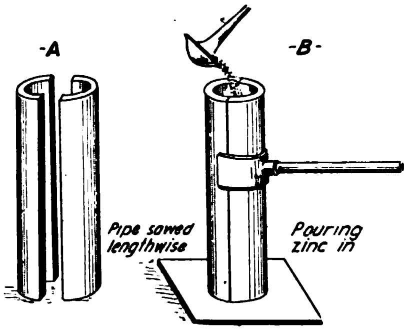
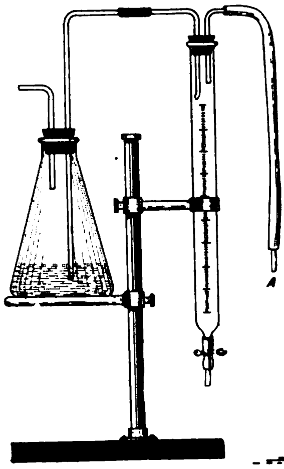


Figure 1—Showing method of constructing zinc spark gap rods



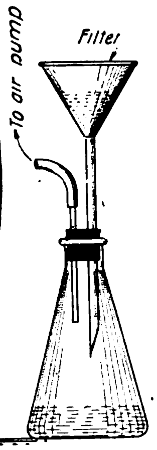


Figure 2—Design of an automatic burette

Figure 3 — Rapid filtering device

In figure 2 is shown an automatic burette that the experimenter can construct with the apparatus at hand. The liquid used in the titration, etc., is put in the flask which is connected to the burette as shown. This is brought into the burette by suction applied at the mouthpiece A. The entire apparatus and the burette is easily filled.

An apparatus for rapid filtering is shown in figure 3. It is connected to a filter pump which is easily constructed by the amateur if necessary.

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Contest Winners for the March Issue

In response to the call in the December issue for manuscripts concerning the re-opening of amateur stations, prizes have been awarded to the writers of the following articles. The suggestion upon which the contest was based was:—AT THE FINAL CONCLUSION OF PEACE NEGOTIATIONS, WHAT DO YOU CONSIDER TO BE THE MOST IMPORTANT REASONS FOR IMMEDIATE OPENING OF AMATEUR WIRELESS STATIONS?

First Prize — Why the Amateur Should Be Allowed to Resume Operations

THE chief reason why the wireless amateur should be allowed to resume, after the war, is the fact that one naturally has the right to use the ether just as one has a right to breathe the air. Recently a power greater than his own compelled the amateur to relinquish the practice of his favorite art. But this power did not and could not take away his rights; it merely forced him to abandon the practice of them for a time. The wireless amateurs do not question the wisdom of this course. What the wireless amateur objects to is not regulation but annihilation. If anything is common property, it is the air and the ether. A man has the right to all the air he can use, but he has no right to control the rest of it; likewise no man or set of men has a right to appropriate the ether to his own exclusive use. All have a right to use it provided they have a due regard for the rights of others.

Station of J. Weiss, Port Washington, N. Y., an excellent type of high-grade equipment, which can be put to good use as soon as Government restrictions are removed

If it be said that the wireless amateur might pick up secret messages, I reply that no information of a confidential nature should be sent by radio except in code. In connection with this phase of the matter it is well to remember that if one were determined to get through a message for an improper purpose, one could do so, law or no law. A man cannot be prevented from buying wire and other materials. Now, it is well known that thousands of people can make all the parts of a wireless set. So if anybody wanted to do any surreptitious receiving, he could pack his instruments and a coil of wire in a suit case, go to some secluded spot, string the wire on trees, connect it up and listen to anything within range. The reception of messages by the evil-disposed cannot be prevented. No class of people has the moral right to take permanent charge of the ether simply because they wish to send information whose publicity would injure or embarrass them.

It is true that a very few amateur sending stations did interfere with other stations prior to the war, but this can easily be prevented. Let a few of these offenders be punished and the rest will reform in haste. The government has the whole matter in their own hands. If they fully prescribe the amateur's sending outfit, they will have full and effective control of him. In order to have effective control the government should prescribe not only the transformer input and wave length, but also the length and height of the aerial and the dimensions of the (sending) oscillation transformer. They should not allow an antenna that requires a condenser in series to be used; there would be danger that the condenser would get cut out! If fair play and good judgment rule, there is plenty of room in the surrounding ether for both the amateur and the commercial operator.

Then the more widespread the practice of the wireless art the greater will be the progress in it. The spirit of inquiry not only produces inventions but actually produces the inventor himself. He is the ultimate result of countless investigating minds.

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An exhibit of the Atlanta Radio Club, indicating a high order of scientific training and practical work in the wireless field, developed by amateurs during the pre-war period

And has our government not had reason to rejoice that there was an army of wireless amateurs in the country when the war came? Suppose the amateur had never built his station or practised the art. In that case would there have been the interest in wireless when the war started that there was? Complete figures are not available, but it is certainly true that thousands of young men, on account of their previous experience as amateurs, fitted themselves in a few months for government work and rendered valiant service to the cause. Shall these young men, when they return, find that their government has condemned their former activities and forbidden their resumption.

The enthusiasm of the amateur should not be overlooked. I am not acquainted with any commercial wireless operators, but I know something about the wire telegraphers. I never knew one of them to make an effort to discover anything new in the art. They have no spirit of interest or curiosity. I have known good practical operators who could not connect up a simple set of instruments. They simply do the work that comes to hand, and their sole desire is to maintain their position on the pay roll in increasing opulence. If the commercial wireless operators have no more of the spirit of inquiry than their brethren of the wires, let us thank heaven for the gift of the amateur and pray for his speedy return to the good work, for he loves the art of wireless for its own sake and is always striving to advance it.

So the matter seems to resolve itself into this: Everybody has the natural right to use the regions of space while he has a due regard for the rights of others. This being a self-evident fact, we should not be required to prove it. The burden of proof is on those who think that the amateur should not invade the ether. We may well ask: What harm has the amateur done or what harm can he do under reasonable restrictions?

S. F. McCARTNEY—*Pennsylvania.*

Second Prize — Why Stop the Growth of an Art That Improves the Man?

THE closing of the amateur wireless stations when we entered the war was a military necessity, and there is no reason why they should not be permitted to open just as soon as this military necessity ceases to exist. In fact a consideration of what amateurs have accomplished and what they may accomplish will disclose many reasons—logical ones, too—for permitting their opening just as soon as international conditions permit.

Only one objection can be raised against them and that is "interference." This is of two classes—one malicious, due to irresponsible, flighty amateurs; the other is just "interfer-

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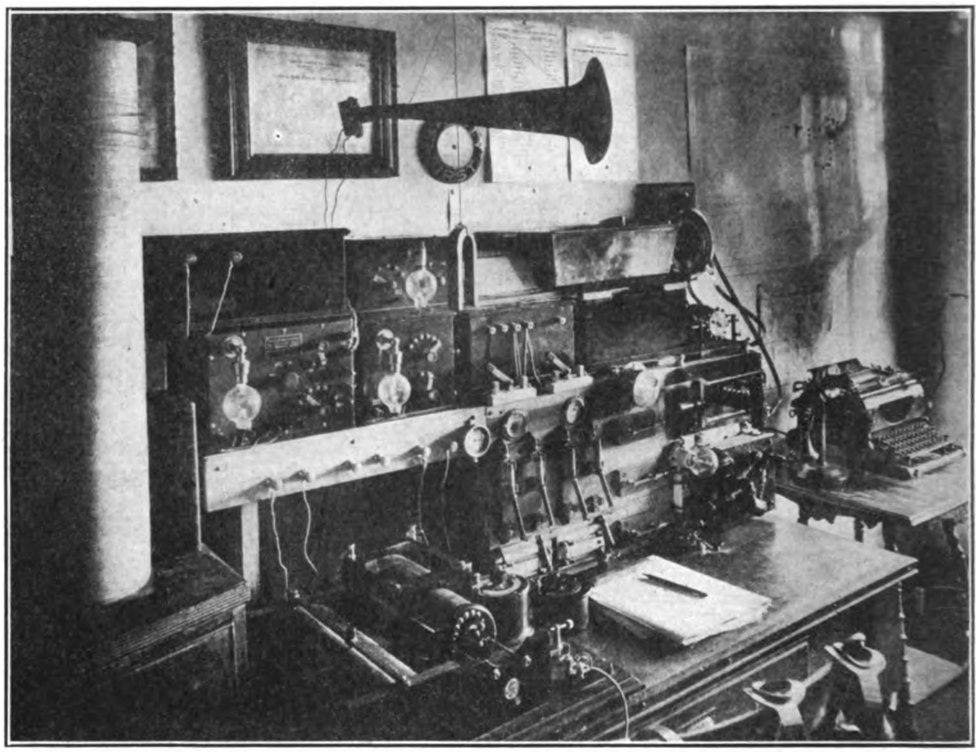
ence" due to lack of scientific knowledge. Both disturb the sincere amateur as much as the commercial or Government stations and the sincere amateur is about 90 per cent of the field.

Malicious "interference" should be and can be punished by existing statutes and the amateur should and will give his aid to bring this about.

"Interference" is a problem recognized and appreciated by all amateurs as well as by radio engineers and is now well on the way to solution.

Amateurs are studying ways and means to overcome interference as well as how to work over long distances with a minimum of energy at the sending station and a maximum at the receiving station.



Amateur station of Chris M. Bowman of Pennsylvania. Scientific work of this nature should be encouraged—not destroyed—by the Government

Their problems are the same as those of the commercial and Government stations and instead of the solution being sought in one or two elaborately-equipped ideally-situated laboratories by an intellect skilled in research work for so much a year, the problem is being attacked by amateurs in thousands of laboratories, where each instrument is worked to its finest point and under thousands of conditions most of which are not ideal; the workers are not skilled in research work and are after immediate practical results.

Prior to the closing of the amateur radio stations their achievements in long distance transmission and receiving and continental relay work, in the better application of old principles and in the discovery of new ones, were noted almost daily. Their results are a matter of record and were gained only by hard work and sacrifice.

The stuff the amateurs are made of, their strength of character, their resourcefulness in an emergency and their ability to deliver the goods was proven in the conflict which has just been closed. "Sparks" as a rule braves danger and risks alone, silently and with no comeback, and not with a company of his fellows, amidst insane din and activity, as does his soldier and sailor brothers.

The foundation for this character and ability was laid years ago in an attic and in most cases under difficulties. An amateur radio operator is not an "operator" from choice but from necessity—he is not actuated by a desire to send a message but by a desire to know how and why the message can be sent at all.

This subject requires much careful investigation and thought; the application of his conclusions develops his manual dexterity. The cost of his instruments if purchased is almost prohibitive; but while they are very delicate and sensitive he may make them himself, from fairly cheap raw material and a few tools.

So we have a condition where a young, enthused mind controls its thoughts, analyzes, puts together, draws conclusions and expresses the results of those efforts in a device in which skill and care in manual effort is a great factor toward the desired result, and it is done for the sake of the work.

An amateur radio engineer is bound to be a better citizen than the average of his fellows because of this training and for this reason he should be given freedom to expand and grow, even if the advantages of the success of his efforts were not available—but they are and he is a tremendous force in the field.

Control his efforts by all means; it will help to make him a better man but no reason has yet been advanced for stopping his efforts, and there is no reason why amateur radio stations should not be permitted to open just as soon as the necessity for closing them ceases to exist. This necessity will have ceased to exist the instant after the treaty of peace has been signed.

F. L. LEMM—*New York.*

Third Prize—Shall Amateur Wireless Stations Be Re-opened?

THE end of the war has brought forth a great many problems that must be settled. One of them, and to a large number of Americans a very important one, is: Shall amateur wireless stations be re-opened at the final conclusion of peace negotiations?

A number of reasons for an affirmative answer can be pointed out.

We have just concluded, with our Allies, a war to "make the world safe for democracy." An important condition for keeping it so is a perfect understanding among the nations. This demands more reliable and better communication than we have had in the past, and here wireless telegraphy can play a role of no little importance.

As this is true of a number of nations, so it applies to a single nation. Added facilities for communication make for better union. This idea, in a large measure, was followed (in America) before we entered the war by wireless amateurs, although they perhaps did not realize it. As time went on, distant parts of the country were brought together by wireless, which brought about a general feeling of brotherhood — an indispensable factor in maintaining a democracy. This feeling of good-will and brotherhood existed invariably in a community having one or more amateur wireless stations. The permission to re-open these stations would be marked by a continuance and an increase of this good work.

In the first days of unpreparedness when our country entered the great war, and when the Army and Navy were in desperate need of young men who understood wireless telegraphy, the inherent patriotism of the amateurs was demonstrated beyond doubt. A great many volunteered, being willing to risk life and limb in the service of their country, whose free institutions permitted the operation of apparatus which had given them so much pleasure and education. And while it is not to be thought for a moment that they served for reward, it surely would be a mark of ingratitude for the Government to take from these fighters and those who helped to make it possible for them to fight, this mode of experimentation which is so beneficial and harmless when properly controlled. Such action would not be worthy of our nation.

There are instances on record of amateurs giving material aid to public officials. For example, an amateur helped prove that our neutrality was being violated by the Sayville wireless station. Once when a shore party from some Naval vessels was unable to establish communication with the ships, an amateur, upon request, did the needful thing. During the heavy floods of 1913 some communities would have been cut off from the world for days had it not been for amateur wireless stations. These instances and others prove that it would be wise to permit amateurs to continue their operations for the aid they could give in emergency or disaster.

Our rapidly growing Navy and Merchant Marine will require a large number of wireless operators. Formerly, even with the aid of the amateurs, the Government and the commercial companies could not obtain sufficient men. Now the need is greater and the difficulty will increase if there is not a large body of amateurs to draw from.

With a great many persons interested in wireless telegraphy the chances for invention and improvement are multiplied many times. Investigation and attempts at improvements are qualities characteristic of every earnest amateur. Beneficial results are bound to follow. For instance, Marconi was but a plodding, persistent amateur when he made his famous and priceless invention. Armstrong, whose amplifying circuits have done so much to extend the scope of wireless telegraphy, had scarcely attained his majority when his discovery was made. And Weagant, who was recently credited with overcoming the greatest enemy of wireless communication, began his task when but a young man. With these examples before us what may we expect in the future from amateur wireless experimenters?

All these reasons, and doubtless others exist, point to the wisdom of re-opening amateur wireless stations as soon as peace negotiations are on their way to final settlement.

ROSS MOORHEAD—*Ohio.*

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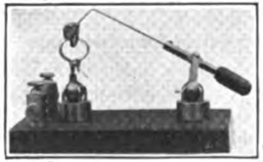

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Both Sides of the Government Ownership Question

(*Continued from page* 21)

the amateur arguments, which were reported in the February issue, several interesting statements were made which space does not permit dealing with here.

Captain Todd then appeared in rebuttal, arguing that the bill had nothing to do with patents or manufacturing in itself. He called for legislation which would further limit amateur operation, the concentration in one authority of coastal station operation, and issuance of licenses for all receiving stations.

Fulton Cutting, of Cutting & Washington, opposed the bill, stating that if it went through he would close out his company, not caring to be in a business where the U. S. Government would be the only customer. Lester L. Israel, radio engineer, gave reasons for his opposition that were an outspoken indictment of the showy and wasteful system in the Navy, as determined by his own experience during four years in the Navy Department. George McK. McClellan, representing the Honolulu Chamber of Commerce, said that Hawaiian business men strongly resented the Navy's bureaucratic administration and protested against the policy of the Government to continue its war control. Emil J. Simon, radio engineer, vigorously attacked the various provisions of the bill and used his own experience to demonstrate how young men could build up a substantial manufacturing business without fear of the Marconi "monopoly," which the Navy had attempted to prove practically existed.

Samuel E. Darby, patent attorney, representing the De Forest Radio Telephone & Telegraph Company, said that the company was "with the Government and in favor of the proposed bill." George S. Davis, general manager, radiotelegraph department, United Fruit Company, who preceded him, took the reverse attitude and showed by comparison that wireless was better for all concerned with the field open for all commercial interests.

The hearings closed with the introduction by Representative Lufkin of a letter of protest from an amateur of Essex, Mass.

As reported in the February issue, the committee, on January 16, by unanimous vote tabled the bill.

Queries Answered

Answers will be given in this department to questions of subscribers, covering the full range of wireless subjects, but only those which relate to the technical phases of the art and which are of general interest to readers will be published here. The subscriber's name and address must be given in all letters and only one side of the paper written on; where diagrams are necessary they must be on a separate sheet and drawn with India ink. Not more than five questions of one reader can be answered in the same issue. To receive attention these rules must be rigidly observed.

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K. K. K., Elizabeth City, N. C.:

Ques. (1)—Is the regenerative beat receiver shown in figure 108 in the book "How to Conduct a Radio Club" more efficient than the modified Weagant circuit shown in figure 69 of the book "Vacuum Tubes in Wireless Communication"?

Ans. (1)—Practically identical results will be obtained from either circuit. The principle point of difference lies in the method of connecting the tuning elements of the plate circuit. In figure 108 the regenerative coupling coil is placed on the low voltage side of the secondary circuit. In figure 69, it is on the high voltage side. The circuits of figure 69 are less difficult to adjust than those in figure 108, for by proper design of the coils in figure 69 all the tuning necessary can be obtained by the loading coil L-1, secondary condenser C-1 and plate circuit condenser C-2, that is, these are the principal adjustments.

Ques. (2)—What would be the approximate range of wave lengths over which the apparatus shown in figure 108 of "How to Conduct a Radio Club," would work with coils L-3 and L-7, 20 inches in length, 6 inches in diameter, wound with No. 28 enameled wire; and if coils L-5 and L-6 were wound with No. 24 and No. 30 enameled wire respectively, the secondary coils being 7 inches in length, 4½ inches in diameter and the primary 7 inches in length, 4 inches in diameter?

Ans. (2)—The set should respond to wave lengths up to 8,000 meters and by shunting secondary L-7 with a variable condenser, still longer wave lengths may be obtained provided close coupling is employed at the coils L-2 and L-4.

* * *

H. C. K., Canton, Ohio:

Ques. (1)—In order to receive signals from both Naval and amateur stations would there be any marked advantage in erecting two separate aerials from the same support, one aerial to consist of two wires 350 feet long and the other of two wires 100 feet long? The wires in each aerial would be spaced three feet.

Ans. (1)—If the vacuum tube detector is employed in the receiver, an antenna short enough to receive amateur wave lengths would also work well on the longer wave lengths such as employed at high power stations. On the other hand, an aerial long enough for reception from high power stations would have too great a fundamental wave length for reception from amateur stations. Moreover, if separate aerials are employed, they should be placed a considerable distance apart, for otherwise, tuning on one aerial will effect the electrical constants of the other. However, this would not be so noticeable if the earth connection of one antenna is broken while the other is employed. For amateur reception a hundred foot aerial is preferable and with a good sensitive vacuum tube or a cascade tube amplifier you would obtain nearly as loud signals from high power stations on this aerial as from the longer one.

* * *

G. T. S., Chicago, Ill.:

Ques. (1)—Can I erect an aerial in my attic of a three-story building?

Ans. (1)—For receiving purposes it will work well, particularly if you use vacuum tube amplifiers to detect the signals. The efficiency will be somewhat lower for transmitting purposes, but fair results over short distances will be obtained.

Ques. (2)—Will lightning effect the house when the aerial is under the roof? It is my understanding that copper wire draws lightning.

Ans. (2)—The aerial would perhaps give better protection if it were outside of the roof because under the condition you mention, if the aerial was struck by lightning it would necessarily pass through the roof of your house to reach the aerial. However, it is rarely that one hears of amateur stations being struck by lightning and you therefore need have no fear on this point.

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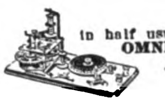

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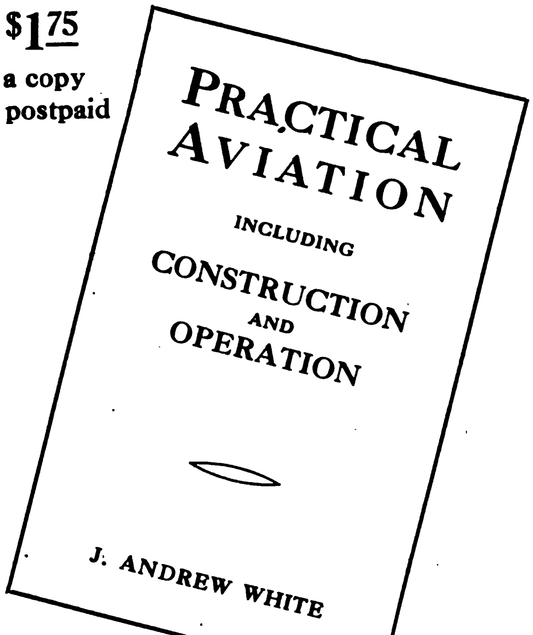

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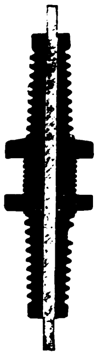

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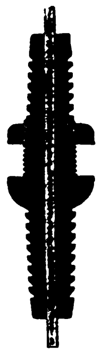

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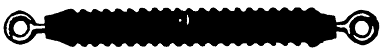

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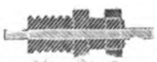

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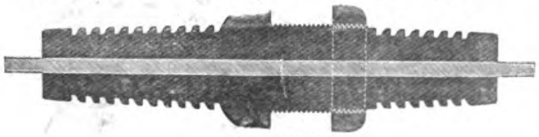

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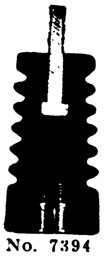

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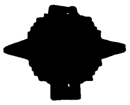

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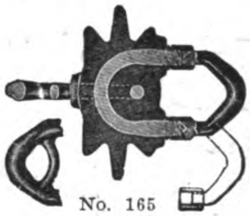

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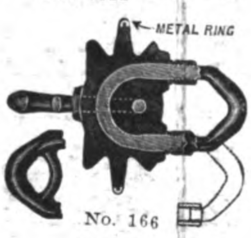

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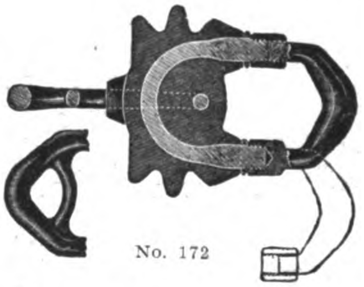

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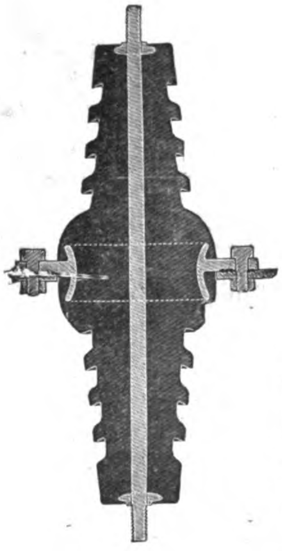

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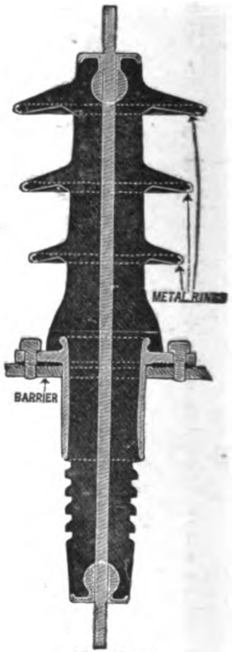

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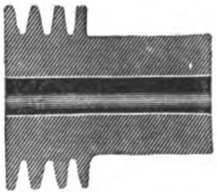

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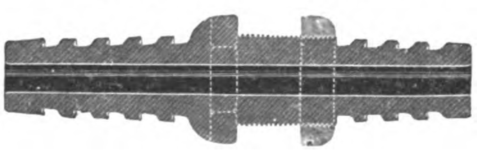

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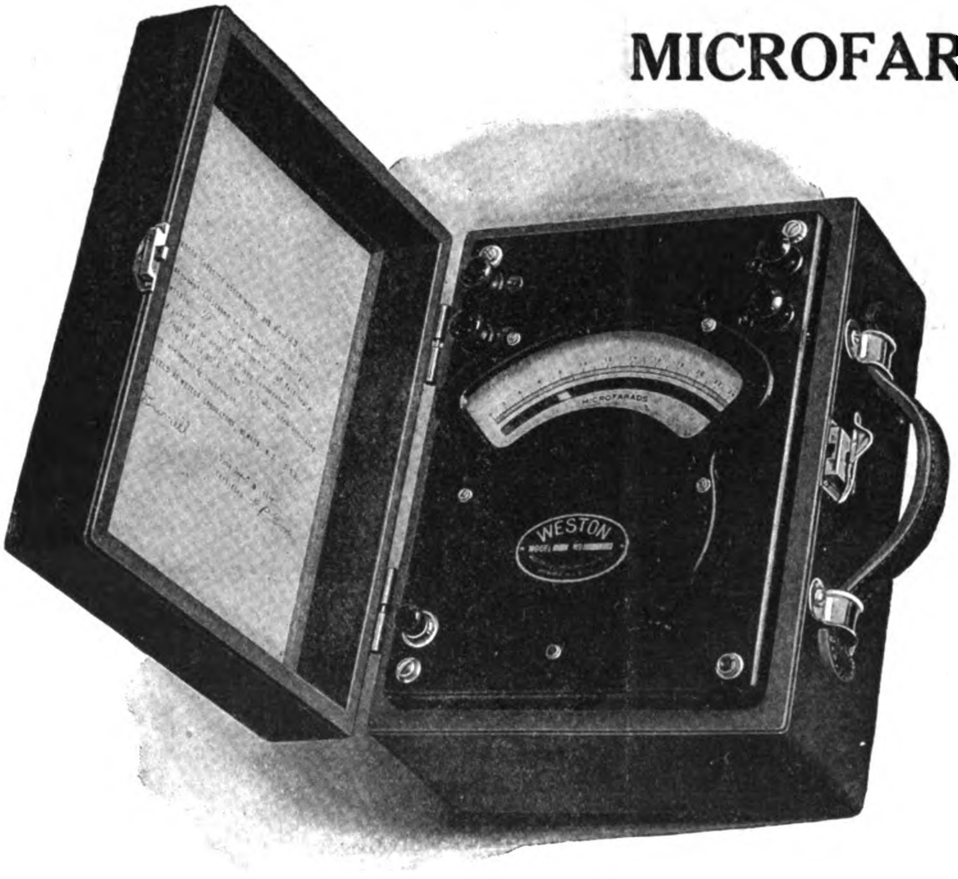

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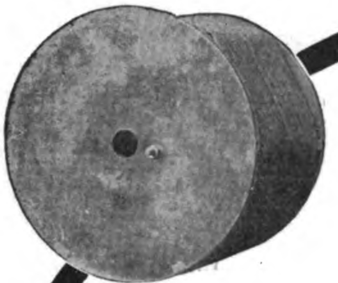

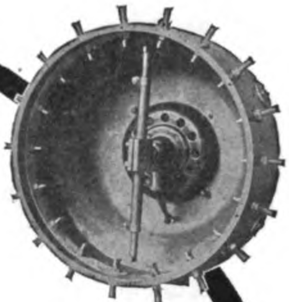

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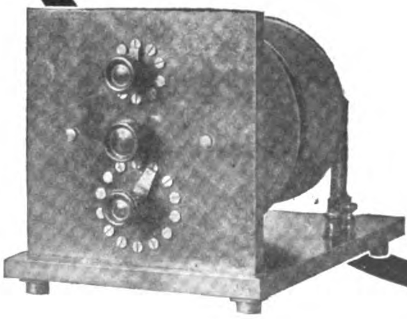

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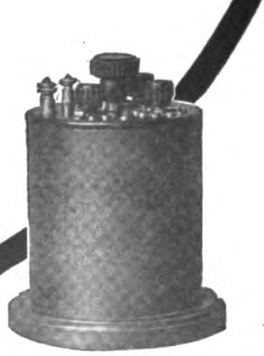

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The Wireless Age

Edited by J. ANDREW WHITE E. E. BUCHER, Technical Editor

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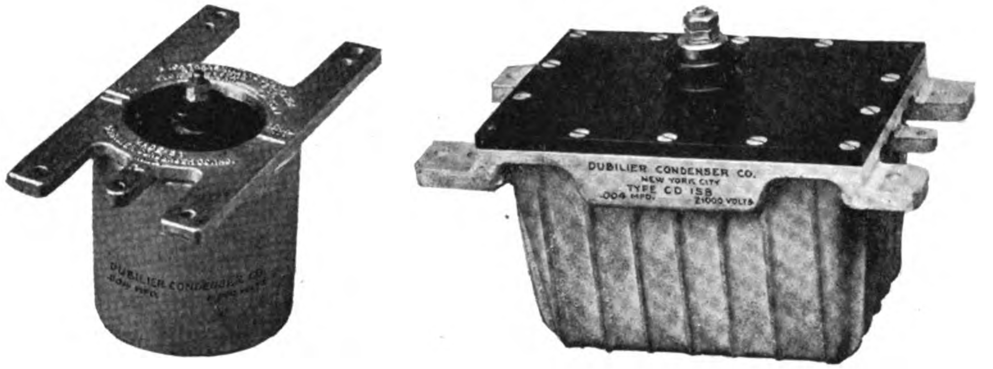

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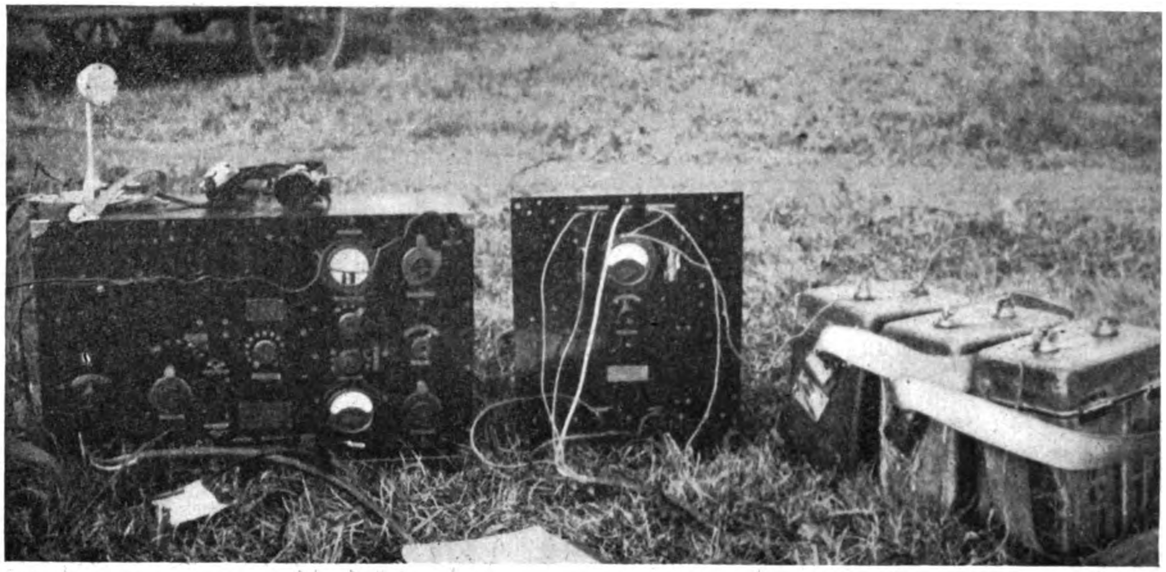
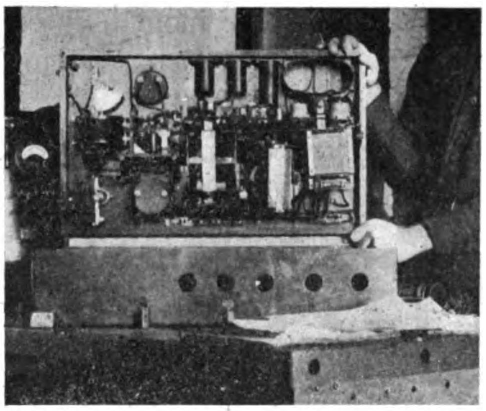


THE ARMY RADIOPHONE

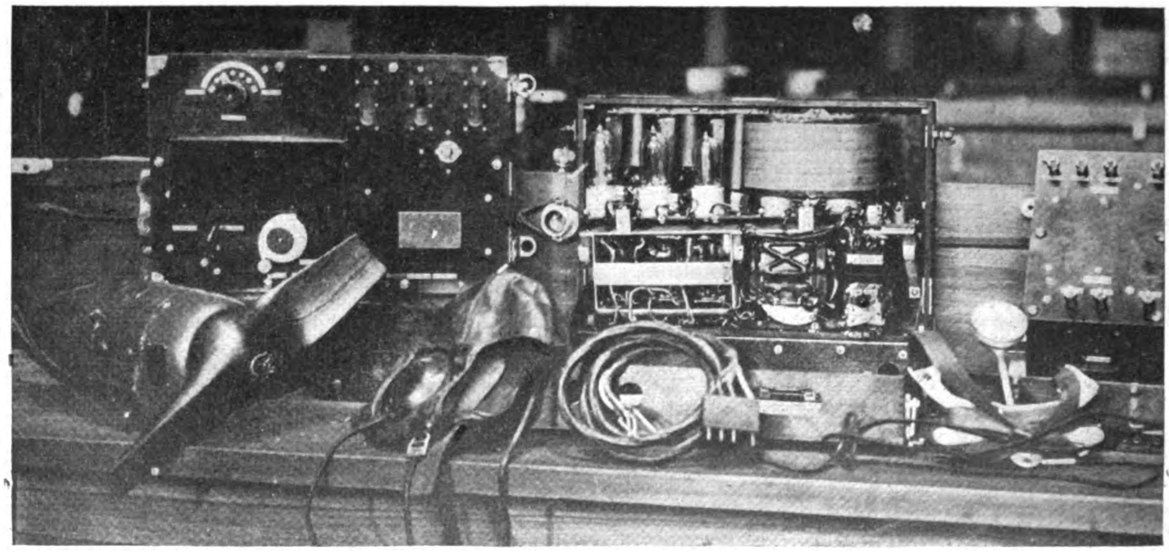
Of undoubtedly great interest to those who did not get the opportunity to work with Signal Corps apparatus are the three illustrations on this page. Above is the radiotelephone ground set; to the right may be seen its three 4-volt storage batteries; in the center, the panel and 300-volt dynamotor; the head 'phones and transmitter are on the top of the set and the automatic relay control button lies in on the ground.



Interior of the radiophone set illustrated above, showing the arrangements without the vacuum tubes; the dynamotor for supplying positive potential for plates may be seen to the left

AIRCRAFT WIRELESS 'PHONE

The airplane radio telephone set: In the left foreground is the wind-driven generator; alongside is the aviator's helmet with 'phones enclosed in soft rubber; to the left rear is the set containing both sending and receiving equipment with two-step amplifier; alongside, set with interior in view, showing bulbs; there are two transmitting bulbs inside the coil; at the extreme right is the transmitter, leaning against the interplane set used for telephone conversation between the pilot and observer.



VOL. 6. No. 7 APRIL, 1919

THE WIRELESS AGE

WORLD WIDE WIRELESS

Weagant's Disclosure of His Static Discoveries Converts Skeptics

CONTROVERSIAL opinions, which followed the preliminary public announcement in November that Roy A. Weagant, chief engineer of the Marconi Wireless Telegraph Company of America, has solved the problem of eliminating static interference, were noticeably absent when he disclosed the secrets of his discovery on March 5th. The skeptics were converted after hearing his paper, "Reception Through Strays and Interference," delivered before a joint meeting of the Institute of Radio Engineers and the New York Electrical Society at the Engineering Societies Building in New York.

The meeting was attended by eminent scientific figures from all parts of the country and the auditorium was filled. The Weagant paper, which was illustrated with stereopticon designs, consumed in its reading nearly two hours. He was given a hearty round of applause at the conclusion of his address, at the end of which Prof. Michael I. Pupin of Columbia University, an early critic of Weagant's claims, arose from a front seat to acknowledge the discovery and invention which had hitherto been targets for his skepticism.

"We have here a momentous step in advancing the art of telephony," he said. "It is a marked improvement in the problem of getting rid of static, a great step. It should be hailed with delight by electrical scientists."

American-Built Lafayette Station Sold to France

THE sale of the great Lafayette wireless station at Bordeaux to the French Government at a price of approximately $4,000,000, and many hitherto unpublished facts of American naval activities in the war were announced here today by Assistant Secretary Roosevelt, who arrived at Boston with President Wilson on the George Washington on February 24th.

"The great Lafayette radio station near Bordeaux was intended to insure communication between Washington and the army and navy in case the cable system was put out of commission or interfered with by German submarines," Mr. Roosevelt said. "It has eight towers, and could communicate with the United States day and night. It was built by the navy. I arranged with the French Government that we shall complete the station, which is two-thirds finished, and they will then take it over at what it costs us, about 22,000,000 francs."

Ten Wireless Stations for Scandinavian Countries

IT is announced in Lloyd's List and Shipping Gazette that a large radio telegraph station has recently been erected at Karlsborg, in Sweden.

The station has a radius of 5,000 kilometers (about 3,100 miles), and will thus be able to communicate directly with America.

In addition to the Gottenborg and Karlskrona stations three others are being built in Sweden—at Boden, Hernosand and Vaxholm, near Stockholm. The station at Karlsborg has two masts, each 210 meters high. The aerials between the masts consist of six wires 450 meters long. The electric current is supplied from the Trollhattan hydroelectric power station, and is converted at the station to a periodicity of 15,000.

Telephone equipment installed in the President's room on board the steamship George Washington

In Norway the Stavanger station is nearly finished. It will communicate with America, where the Marconi Company has built a sister station. Its radius will be equal to that of Karlsborg.

Rundemand station, near Bergen, with a radius of 800 to 1,100 kilometers, has been in use some time, and Tryvand station, near Christiania, will be ready in the near future.

Radio Devices for Mapping Arctic Regions

AN important contribution toward the success of the Roosevelt Aerial Arctic Expedition, to be headed by Captain Robert A. Bartlett, was announced at the thirteenth annual dinner of the Aero Club of America. John Hays Hammond, Jr., stated that he has devised a system by which maps of the Arctic regions may be made with unprecedented speed and accuracy through the use of radio devices.

Mr. Hammond, in his address, said in part:

"The war has contributed three important scientific developments for the purpose of exploration—first, the aeroplane; second, the application of radio signaling to aircraft; and, third, the development of aerial photography.

"I have devised a system, the main principles of which are extremely simple, embodying these three technical developments in a system of aerial surveying, utilizing which it should be possible for vast tracts of territory to be mapped with accuracy and speed never before attained in mapping.

"It is hoped by the Aero Club to apply this system in the exploration of the Polar basin, a vast territory, concerning which man has but little knowledge. We hope to achieve by the use of these new instrumentalities the results in a few months which before would have required years of the enduring and almost superhuman struggle which characterized Admiral Peary's extraordinary achievements."

Mr. Hammond then explained that a number of radio direction-finding bases would be established on a base line from Mackenzie Bay to Cape Columbia. The airplanes used for exploration would be equipped with radio transmitters.

Then the aviator, at a rate of eighty miles an hour, will fly over the regions. By various tests he will distinguish land from ice floes, and once he finds land he will fly along its contour, encircling it. His signals will be picked up by the finders along the base line, keeping check on his movements.

A photograph is taken from the machine at each signal. These pictures all attached will show a progressive outline of the coast and can be checked up by the chart made at the base line stations.

Patriotism and Profits Revealed in American Marconi Report

IN the annual report of the Marconi Wireless Telegraph Company of America the operations for the fiscal year show, before allowing for reserves, a net income of $998,358.14 as compared with $780,592.44 for the year 1917.

The net profits for the year, after utilizing $286,516.37 for reserves, amounted to $711,841.77 as against $617,772.69 in 1917, or an increase of 15.23 per cent. This amount has been added to the surplus, increasing that account, after payment of $499,975.00—1918 dividend—to $1,631,415.78 at December 31, 1918, and the reserves set aside at that date for depreciation amount to $629,176.27 additional.

The directors call attention to the dividend of 5% per annum which was paid August 1, 1918, and to the declaration of another dividend of 5% per annum payable July 1, 1919, to stockholders of record June 1, 1919.

Noting that the company continued in 1918 its whole-hearted efforts to cooperate with the government in every way possible, in the conduct of the war, the report observes:

"Of approximately 1,200 male employees on its roll, 456 were numbered in the stars of its service flag, and seven were called upon to make the supreme sacrifice for their country." Mention is made of the official recognition of the company's war service expressed by Commander S. C. Hooper, of the Navy Department, which THE WIRELESS AGE published in its earlier account of the hearings on government ownership of wireless. The testimony of the Marconi officials before the House Committee is made a supplement to the report, with a caution to stockholders to remain on the alert and to protest against any new attempts to pass measures destructive to the business of the company.

Sound Transmission by Rays of Light Reported from London

A COPYRIGHT dispatch from London to the Press Publishing Co., stated under date of March 8th, that the London Daily Express understands that wireless telephony by the use of light rays has been discovered and successfully experimented with by a young doctor of physics at University College of London. A message sent by the new wireless telephone is, in effect, a spoken heliograph, and wherever it has been practicable to send a Morse code heliogram by flashes it will be possible, when the invention is developed, to send spoken words. The experiments were carried out for the Admiralty during the war. Mr. Balfour, then First Lord of the Admiralty, and Admiral Beatty, sitting in a flagship in the Firth of Forth, were able to talk over the light ray telephone direct to the Admiralty and receive messages back. Later the apparatus was placed in submarines and used with success.

Hammond's Wireless Controlled Craft Approved

ARMY and navy experts have reported favorably on the device of John Hays Hammond, Jr., for radio control of surface craft to be sent laden with explosives against enemy ships. They predict similar results with submerged craft showing above water only wireless antennæ.

Before finally deciding on the purchase of the patents for $750,000, the board desires further experiment with the submerged craft and a change in law for the experiments is necessary to permit building so as to make success certain before purchase.

Construction of the submerged craft which will be about 80 feet long, by 7 feet in diameter, will take two years, according to Mr. Hammond, who told the committee he has spent ten years and $400,000 on his invention.

"There is no question whatever as to the ability to control with great accuracy the torpedo or carrier, whatever kind it is," said a letter to Major-Gen. F. W. Coe, a member of the board, "so long as it is a surface vessel or has any antennae above the water, by direct radio waves, either from shore or from airplane.

"The board had before it also, and considered, the ability of the enemy to interfere with the control of the vessel by radio energy. Mr. Hammond's claims are that no interference can be had with the craft outside a radius of 100 to 250 yards from the source of the energy; that is, from the radio plant of a battleship, for example.

"Within such a radius a certain interference from a powerful wireless station is possible, but that interference with the apparatus only operates to keep the torpedo on a fixed course on which it may be running."

With a shore station having a height of eighty feet above sea level radio control of the craft has been demonstrated to the board up to a distance of about seven miles.

"A surface launch with the apparatus on it," said Gen. Coe, relating demonstrations before the board, "was controlled from both the shore and from an airplane, the means of control in each case being the same. The board also witnessed the dropping of depth charges from the stern of the boat while it was proceeding on any desired course."

Gen. Coe said he had run the craft "all around vessels coming into the harbor at will," and at close ranges there would be no difficulty in ramming a vessel from shore.

Mr. Hammond said an aviator after four hours training on control was able from a height of 9,000 feet and a distance of six or seven miles to exercise absolute control over the high speed boat.

Overseas Radiophone Talks a Certainty

CONVERSATIONS by wireless with Europe were predicted for the near future in a newspaper interview given by Edward J. Nally, vice president and general manager of the Marconi Wireless Telegraph Company of America, who returned on March 9th on the Dutch liner Nieuw Amsterdam, after spending five weeks in France and Belgium arranging for the resumption of the normal flow of commercial wireless and for the installation of the recently developed system of radio telephony.

"The scientists of Europe are greatly impressed and enthused with the discovery by Roy A. Weagant, which eliminates the static troubles that hitherto have been the bane of wireless communication in bad weather," Mr. Nally said.

"In the not very distant future you will be able not only to use your telephone to call up a friend in Chicago or San Francisco and converse by wireless, but the radio telephone soon will be developed to a point permitting similar talks from America to Europe.

"It is now possible to use the telephone you have at home in connection with the wireless, thereby cutting down, as the installation of wireless apparatus on telephone systems grows, the need for more telephone trunk lines, and thus doing away with an increase in the material used in construction of telephone trunk lines."

Congressman Believes Wireless Development Has Doomed Wire Systems

ALL the telegraph and telephone poles, wires and instruments will amount to "scrap" in a year if the progress now being made in wireless communication continues, Representative Steenerson, of Minnesota, ranking Republican member of the House Postoffice Committee, predicted on January 30th.

"Radio communication is the coming thing," Mr. Steenerson said. "It is making such rapid strides that before the end of the year the average American will not be bothering much about the transmission of an ordinary message over an ordinary telegraph or telephone wire or as to whether the ordinary telephone or telegraph wire is owned or controlled by governmental or private interests."

Congressman Steenerson declined to comment upon the report that most of the telegraph and telephone companies would be glad to turn over their properties —which they now estimate to be worth about a billion dollars—to the government, if they would be permitted to invest their capital in wireless communication which they are said to regard as certain to supplant present methods.

Testimony given before the House Merchant Marine Committee as to the possibility of radio communication replacing present methods, Mr. Steenerson added, bore out his argument that "there was no reason for anybody to become unduly excited over the question of government ownership of wires."

"It will mean," he said, "that the properties of the Western Union Company and the American Telegraph and Telephone Company, as well as that of the Postal Company, will change so in form as to represent systems not at all comparable with their present ones."

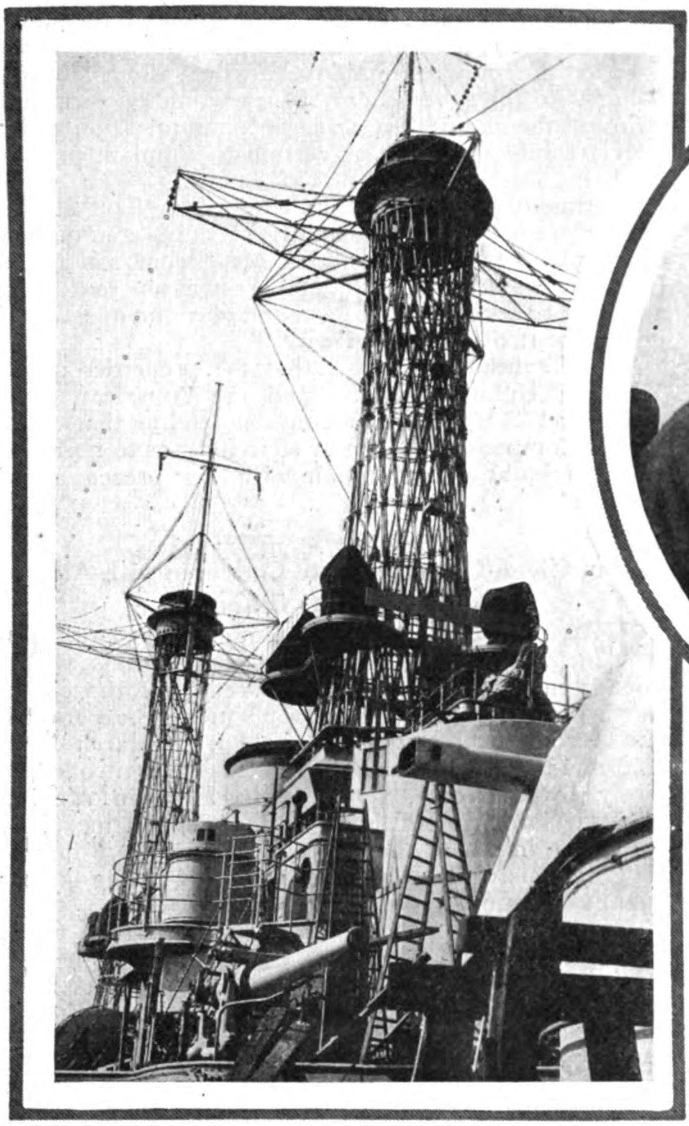
Public Given Opportunity to Converse with Aircraft by Wireless 'Phone

NEW YORKERS had the unique privilege of listening to wireless telephone conversations with a squadron of airplanes which soared over the city in battle formation each afternoon during the period of the Aeronautical Exposition, held from March 1st to March 15th. The squadron flights were controlled entirely by wireless telephones installed in Madison Square Garden and the 69th Regiment Armory, the buildings in which the aircraft exhibits were housed. The demonstration was an official part of the government's feature at the exposition.

The novel feature was the privilege given to the general public to wear flying headgear and helmets during the period when formation flying was under way. Visitors were permitted to converse with the squadron commander, and also listen to the orders given from the ground, and from the squadron commander to the rest of his pilots.

Andrew A. Allan of Canadian Marconi Company, Dead in Montreal

THE loss of a pioneer in commercial wireless was recorded when Andrew Alexander Allan, a member of the well-known shipping family of Montreal, died on February 11th, in that city. He was the son of the late Andrew A. Allan, founder of the Montreal Ocean Steamship Company, whose vessels were operated as the Allan Line of steamships. He was born in Montreal June 15, 1860, and was educated at Rugby, England, and by private tutor. For almost his entire business life he was identified with the Allan Line. He was also connected with several other large corporations, having been, up to a few weeks before his death, the president and a director of the Marconi Wireless Telegraph Company of Canada, the shipping Federation of Canada, and the Dominion Dry Dock Company.



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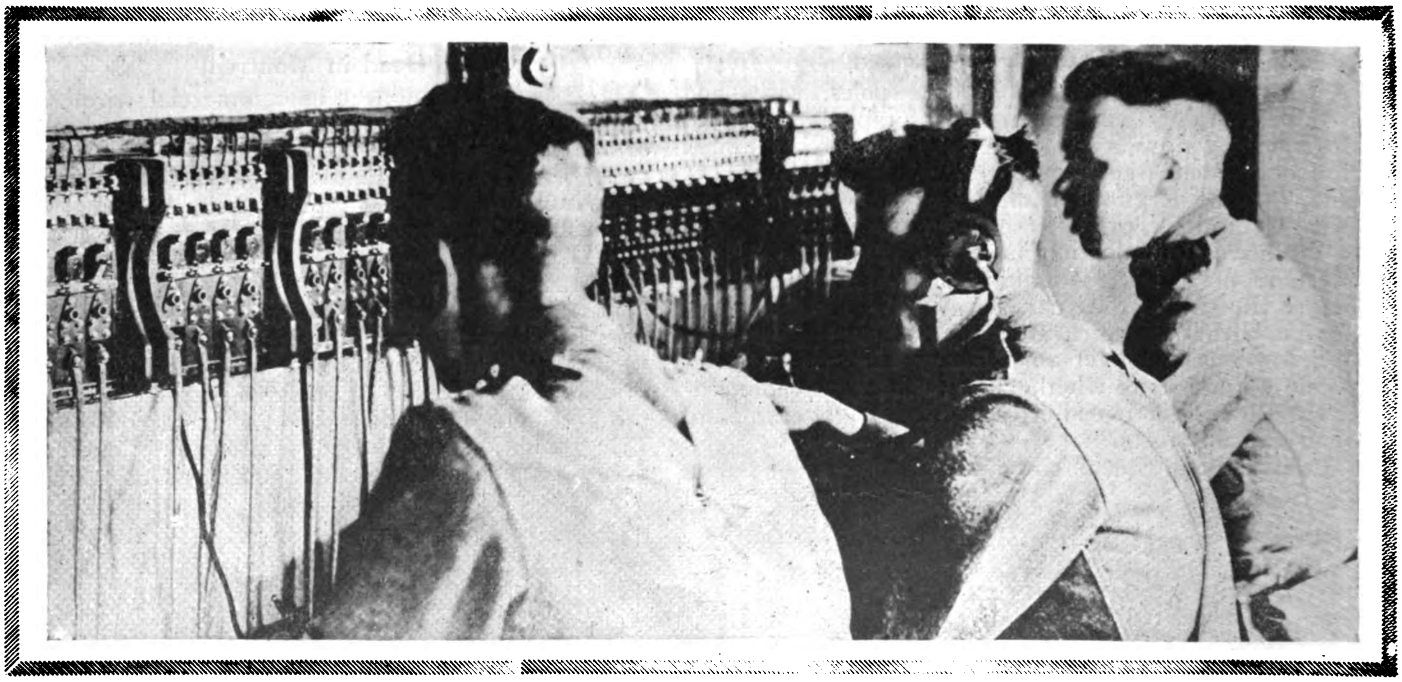
Army and Navy Methods

An interesting arrangement of wireless aerials to obtain extra capacity may be noted in the view of the U. S. S. Idaho, on the left; in addition to the usual double triangular form of antennae on hexagonal spreaders, festoons of ring-spread wires are draped from the masts. In the circle above are two of the army's wounded, one-armed heroes, mastering buzzer communication



Work of the former 1st Bn. Signal Corps, Pennsylvania militia, is illustrated by the above photo of a telephone and telegraph exchange in Abeele, Belgium, during the latter part of August. Left to right, the men are: Privates H. G. Smith, E. K. Daly and H. R. Shaw, all of Company C, Hdqrs. 108th Regt. Infantry, 27th Division

Weagant's Anti-Static Invention

Details of a Great Discovery Which Has Revolutionized Long Distance Wireless Communication

An abstract of a paper read before a joint meeting of the New York Electrical Society and the Institute of Radio Engineers at a monthly meeting, Wednesday, March 5, 1919.
In Two Instalments.

PART I

Reported by Elmer E. Bucher

Director of Instruction, Marconi Institute

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TO a large and enthusiastic audience composed of radio engineers and scientists of prominence, at a joint meeting of the Institute of Radio Engineers and the New York Electrical Society, held March 5, 1919, Roy A. Weagant, Chief Engineer of the Marconi Wireless Telegraph Co. of America, delivered a paper describing in detail his apparatus for the elimination of the great bug-bear of transoceanic wireless communication—static interference.

So quiet had the details of Weagant's great discovery been kept that few in the audience had the slightest inkling of the fundamental principles upon which the operation of his system is based. And so convincing was the explanation given by the speaker that even the most skeptical were compelled to admit that the discovery was not the result of speculation in theory, but was the outcome of a progressive series of orderly, scientific investigations founded on sound scientific principles.

In the subsequent discussion of the paper, one of the first to laud the inventor was Dr. Michael Ivadorsky Pupin, world famous scientist, who remarked that whatever may be our opinion of the theory advanced supporting a seemingly vertical propagation of static, the outstanding fact remained that Mr. Weagant had demonstrated beyond all doubt that his apparatus was a practical operative proposition and, after all, this was the all-important thing to be considered.

He congratulated the inventor on the success attained and remarked that the discovery was one great stepping stone toward the final solution of the ideal wireless system. He hoped that radio engineers would now give their attention to the development of an amplifier which would permit transoceanic communication with very small powers, for, as he jocularly remarked, the average college professor with his limited pocketbook could not accustom himself to think in terms of 200 kw. radio frequency alternators and enormous receiving aerials such as now are employed! He felt, however, that the commercial success of transoceanic communication is now assured.

David Sarnoff, Commercial Manager of the Marconi Company, brought out the fact that for the first time in the history of electrical communication we are enabled to establish a telephonic service between countries separated by the oceans, noting that in the some 60 years of the practical applications of electrical signaling, no solution of the problem had even been suggested. He also threw an interesting sidelight on the inventor's ideas regarding nature and its laws, declaring that Mr. Weagant once remarked that he could not conceive that Mother Nature, having given to mankind such a priceless boon as wireless communication, would deliberately put into force another unsolvable law which would destroy its usefulness. Mr. Weagant had held to this belief firmly, and his subsequent success would seem to indicate that his discovery had initially more of the nature of an inspiration than had ordinary scientific achievements.

G. H. Clark, Expert Radio Aide, U. S. N., who had been assigned to the U. S. Navy Department to witness the experiments of Weagant, testified to the indefatigableness of the inventor, ascribing his success to stubborn persistence and willingness to abandon a mere theory in favor of an experimentally demonstrated fact. He stated that he was amazed at the results secured in the very earliest experiments, which he was privileged to witness, and that, concerning the ability of the Weagant system to weed out static, there could be no doubt.

F. N. Waterman, who has been closely associated with Weagant from the inception of the invention, praised the inventor for his daring in attacking a problem of such magnitude and declared that it was the ability of Weagant to recognize the fallacies of all previous systems purporting to eliminate static that enabled him to evolve a practical method of wireless reception of wonderful, commercial and scientific value. He recounted in a most interesting manner the results of early experiments, and the many obstacles and discouragements met with and overcome.

He stated that after complete success had been attained, it was almost uncanny to pick up a telephone receiver, at a long distance radio receiving station, in which the crashes of atmospheric electricity were so loud that it was next to impossible to detect the wireless signal, and then to simply throw a switch and note the static disturbances disappear to a degree that required a trained ear to hear them; and simultaneously to note the wireless signal so increased in intensity as to make it easily readable.

E. F. W. Alexanderson, of radio frequency alternator fame, said that when it was first mentioned that a hitherto unknown law of nature had been uncovered, he was somewhat skeptical regarding it, but now it was plainly to be seen that the speaker of the evening had made a discovery which gave practical results.

Previous to the meeting much speculation had existed regarding the newly observed law of nature disclosed by Weagant's experiments, and while the speaker plainly asserted that his theory regarding the origin of a particular type of static may yet call for some revision, the reported results of his researches, in a large measure, justified, in the judgment of those present, the belief that Weagant had observed and made practical use of a hitherto unknown static phenomenon.

Classification of Static or Strays

As a beginning, Mr. Weagant first classified strays after the well known method of Eccles, pointing out from his observations the distinction between the types that represented genuine obstacles to transoceanic communication and those which caused but occasional interference and could therefore be ignored. Static disturbances due to local lightning and snowstorms were ignored, for the reason that these types are of so infrequent occurrence as to be of negligible importance; but there remained the three types, termed, "grinders," "clicks" and "hissing." The last named, which are due to an actual discharge from the aerial to the earth, give no trouble in the ungrounded aerials used in the Weagant system. Of the remaining two types, "grinders" and "clicks," the former were found to constitute the major source of difficulty.

Some Fallacious Ideas Exposed

The success of Weagant's endeavors to eliminate from the receiver the most troublesome forms of atmospheric electricity may be attributed primarily to his clear recognition of the limitations of all so-called static elimination previously evolved.

Take, as an example, the well known receiving circuit in figure 1. His experiments and observations revealed that the static currents induced in the aerial system, A, L-2, L-3, E had the *frequency* and the *damping* of the antenna circuit itself, no matter what frequency of oscillation to which it happened to be adjusted. It therefore became evident that if one were to separate, by any sort of a device, the static currents in the antenna system from the signal currents, he would be confronted with the proposition of separating two currents of the same frequency in the same circuit.

Points of Interest Disclosed by Weagant's Experiments

THE static currents induced in a receiving aerial by static "waves" are of the same frequency and of the same damping as the complete receiving system.

When the oscillation frequency of the antenna circuit is altered by local tuning, the frequency of the static currents changes in accordance.

For that reason, the differentially connected, branched aerial system proposed by Fessenden is ineffective in reducing static; for when one branch is detuned to the wireless signal, static currents of different frequency exist in the two different branches. Obviously, two currents of opposite phase but of different frequency cannot be made to neutralize one another.

Mr. Weagant's researches prove that all forms of static eliminators utilizing differentially connected audio or radio frequency circuits, are of little or no value for continuous long distance wireless reception.

The dominant type of static waves, called "grinders," apparently is propagated vertically in respect to the earth. Therefore the static "waves" resulting therefrom are at right angles to the wireless waves. By the use of properly disposed aerials advantage can be taken of this phenomenon to separate the static and the signal currents.

Two closed circuit loop antennae, spaced ½ wave length from center to center, the planes of which are in the path of a passing wave, will be acted upon simultaneously by the vertically propagated static waves, but at different times by the horizontally propagated wireless waves.

Hence, when both loops are correctly coupled to a common receiving set, the static currents will be in phase and may be neutralized. The signal waves will be out of phase and will not neutralize, but will add their E.M.F.'s vectorially.

By proper adjustment of the phases of the currents in one loop, in Weagant's antennae system, uni-directional reception is possible, signals of maximum intensity being secured from waves arriving at one end of the loops, while interference from the other end of the loops may be annulled.

Underground or surface-ground aerials act as ordinary closed circuit loops erected above earth. By reason of the capacity effects between the ends of the aerials and the earth, a return path for the induced currents is afforded, which effectively closes the circuit.

The greater the capacity per unit length between the underground or surface-ground aerial and the true underlying earth, the shorter is the maximum length which can be used to advantage. This accounts for the fact that approximately 2500 feet is the maximum length that can be employed for underground aerials placed under brackish water.

Experimenters, heretofore, had tried to get rid of static interference by detuning the antenna circuit, by differentially combining two radio frequency receiving circuits, by differential connection of two detectors of different characteristics, by differentially combining two audio frequency circuits, as in DeGroot's method, and finally by the use of the Dieckmann shield.

The hoped-for results in detuning the antenna circuit could not be realized because such detuning did not reduce the intensity of the static signal, but simply changed its frequency. The loss, in the transfer of static energy to the secondary circuit when tuned to the frequency of the incoming signal, is exactly the same as the loss in intensity experienced by the signal currents through detuning the antenna. This, of course, does not improve conditions in the slightest, for it reduces the static and the wireless signal in the same ratio.

Some improvement has resulted from the use of loose couplings between the primary and secondary circuits, provided there is a marked difference between the damping of the signal and static currents; but the relief was by no means sufficient to be of any considerable value when working over great distances.

The "interference preventer" next came in for well deserved criticism and was proven by Weagant to be ineffective. As many of our readers are aware, Fessenden coupled, differentially, the two legs of a branched aerial, or the primary circuits of two separate aerials, to a common detector circuit as shown in figure 2. He concluded that if one branch, say A, be tuned to a transmitting station and the other branch, B, be detuned, static currents of equal intensity would be induced in both sides and would be annulled, and that, as the signal in one branch had little or no opposition from the other branch, it would be heard. He assumed the static currents to be forced oscillations and, therefore, that their frequency and intensity were unaffected by an amount of detuning that would *greatly affect* the signal. This, as Weagant clearly pointed out, is an absolute fallacy.

The fact is, that when one branch of the antenna circuit is detuned, the frequency of the static signals changes accordingly, leaving static currents of one frequency in one branch, and of different frequency in the other branch. It is, obviously, not possible to *balance out two opposing E.M.F.'s of different frequency*. Moreover, the detuning of one branch affects the intensity of both the signal and static currents in the secondary circuit in the manner just explained.

It is important to note here that two opposing E.M.F.'s can completely neutralize each other *only* when they have the *same frequency, the same wave form, and opposite phase.* And in the case of damped oscillations, in addition to these requirements, the dampings of the two E.M.F.'s must be identical. The writer feels assured that readers will at once recognize that the steps by which Mr. Weagant eventually arrived at the result attained in his receiving system, constitute one of the most original applications of engineering principles ever made in radio telegraphy.

Continuing, Mr. Weagant said that if any experimenter had secured worth-while results by means of a differential audio frequency circuit, such results have been due to the looseness of coupling involved in the circuits under test. He pointed out also that the effectiveness of balanced detector circuits is due solely to the protection against loud crashes afforded to the ear of the operator. Regarding the Dieckmann shield and the ability of the combination system to reduce static, as described by DeGroot, the speaker declared that he could see no basis therein for differentiating between static and signals, and that investigation had proved that the problem of screening out any electromagnetic wave of any sort, either signal or static, cannot be solved by that method.

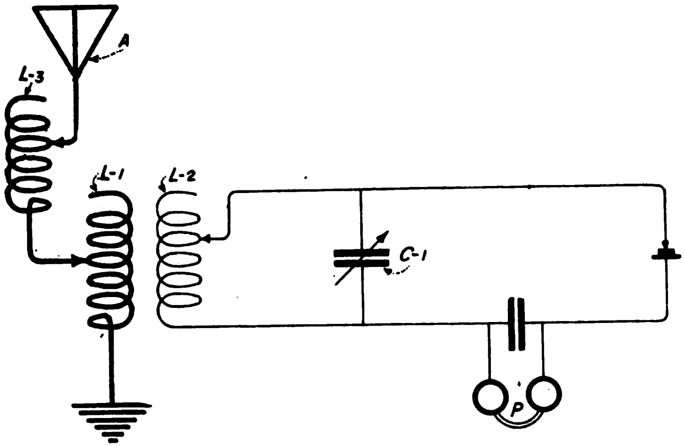


Figure 1—Diagram of an ordinary receiving system in which, as Mr. Weagant points out, the frequency and damping of the static currents are the same as that of the complete receiving system itself. As a consequence, when the oscillation frequency of the antenna circuit is changed by local tuning, the frequency of the static currents change accordingly

For experimental observations Mr. Weagant constructed various forms of aerials, including the horizontal linear—underground and surface-ground aerials. Some of these were found to appreciably reduce static, but the general characteristics of the underground type proved, under experimental investigation, to be entirely different from theories recently advanced. Mr. Weagant's deductions in respect to this aerial will be stated further on.

Some Important Observations Regarding Static

In an effort to determine, by means of the Marconi-Bellini-Tosi direction finder (shown in figure 3), whether or not static was horizontally directed; that is, if it originated from any particular direction at certain hours, Mr. C. H. Taylor, a Marconi engineer, carried out a series of experiments at Belmar, N. J., with apparatus designed for the reception of long waves over great distances. Experiments were also carried on by Mr. Weagant, at Belmar, and simultaneously at another station erected at the Marconi factory at Aldene, N. J.

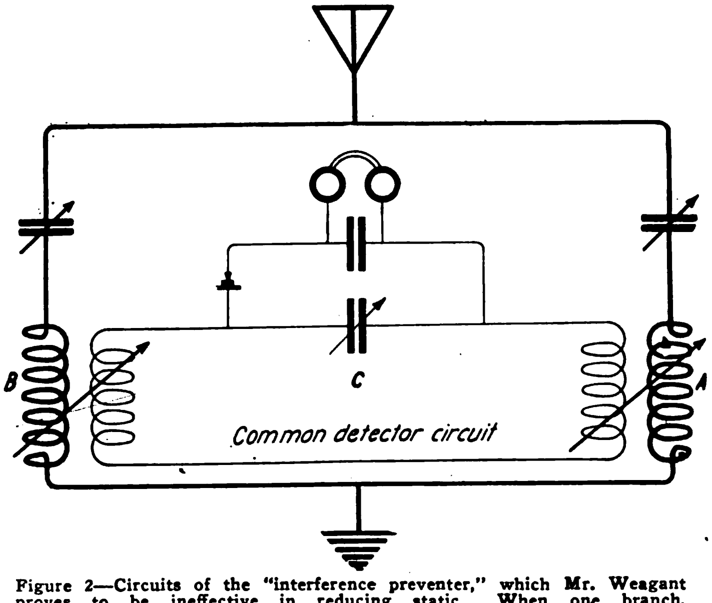


Figure 2—Circuits of the "interference preventer," which Mr. Weagant proves to be ineffective in reducing static. When one branch, say A, is detuned to the wireless signal, the frequency of the static currents change accordingly; hence, static currents of one frequency flow in one branch and of another frequency in the second branch. It is obvious that two currents of different frequencies cannot be made to neutralize each other

These tests seemed to indicate conclusively that the dominant type of static—"grinders"—apparently came from no definite direction, but *gave an equality of disturbances from all points of the compass.*

A further check on this observation was made by rotating a closed circuit loop (see figure 4) connected to a receiving set, about the vertical axis, A. The loop showed equality of disturbances regardless of the direction of the plane of the loop.

These experiments, as Mr. Weagant said, indicated that if static disturbances of the "grinders" type were propagated horizontally, they must come from different directions, and so rapidly that the observer would have no opportunity to manipulate his apparatus with sufficient rapidity enough to determine their direction.

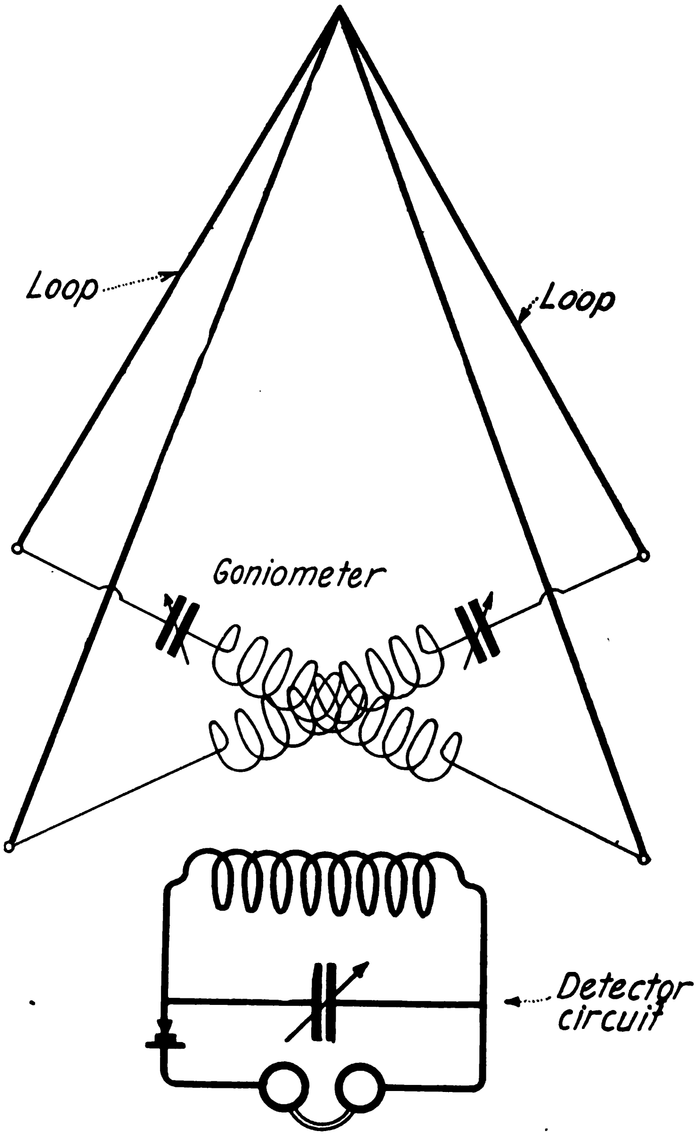


Figure 3—Fundamental circuits of the Marconi-Bellini-Tosi radio goniometer with which experiments were conducted at Belmar, N. J., by C. H. Taylor and R. Weagant to determine whether static signals emanated from any particular direction. The investigation proved that the dominant type of static called "grinders" apparently came from no definite direction but gave an equality of disturbances from all points of the compass

Weagant's Great Discovery

It then occurred to Mr. Weagant that these static disturbances might be propagated *vertically,* instead of horizontally, and if so the *direction of propagation would be at right angles to the direction of the advancing wireless wave.* If that could be definitely proven, then advantage might be taken of the difference in direction to separate the static from the signal currents flowing in the antenna

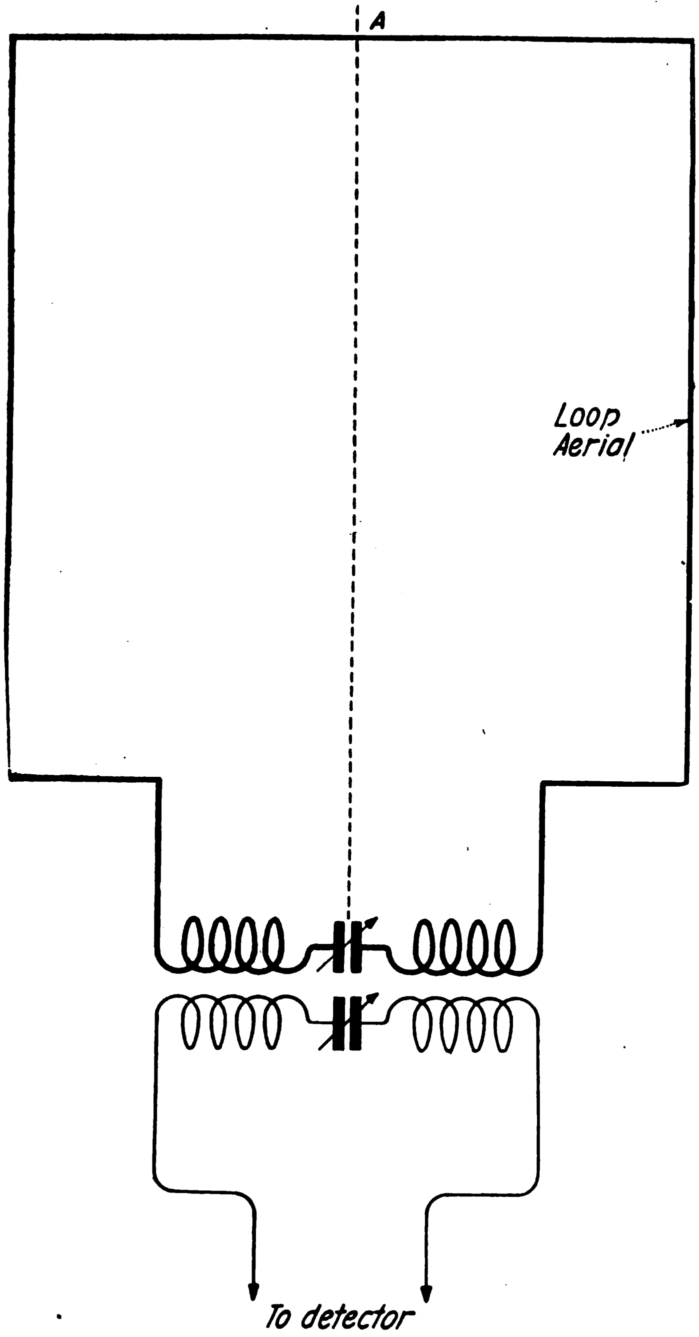


Figure 4—Loop aerial used by Weagant to check up the observations made with the apparatus in figure 3. The loop was rotated on the axis A to determine the line of direction of the static waves. The experiment proved that these waves came from no definite direction

circuit. This was the fundamental working hypothesis on which the Weagant system is based.

A series of experiments to verify the hypothesis then followed.

Observations on Two Loops, the Planes of Which Are Perpendicular

For one thing it was found that when two loops, the planes of which were perpendicular, were connected to a common receiving apparatus, as in figure 5, the static currents *could not be balanced out.* The experiment justified the assumption that *electromagnetic waves responsible for static currents are heterogeneously polarized;* that is, the axes of the oscillators producing them assumed all possible angles in space; and the highly damped waves resulting therefrom are propagated in a direction perpendicular to the earth's surface.

In other words, to the unscientific mind, these static waves may be described as an electric shower which acts upon an aerial, perpendicularly to the earth.

An Early Form of Weagant's Static Eliminator

To determine the correctness of the hypothesis that static is propagated vertically and to ascertain if it were possible on this assumption to devise a system whereby the static currents could be balanced out while the signal was retained, Mr. Weagant erected at Belmar, N. J., the aerials and apparatus shown in figure 6. Two closed loops A and B, each consisting of a single turn of wire 400 feet high with a base line of 1,000 feet, were spaced 5,000 feet from center to center. Two wires, brought from each loop to a receiving station located at the center, were supported on ten-foot poles, 6 feet apart. These leads were connected to the primary coils of a goniometer of the type used in direction finders; the secondary coil was connected to a sensitive oscillation detector. It was this apparatus that permitted the reception of transatlantic signals through static interference of great intensity, whereas without it, it was impossible to distinguish the wireless signal.

The connections to the receiving tuner and detector are shown in figure 6, where loop A has the loading coils L-1 and L-2, the resistances R-1 and R-2, and the coil,

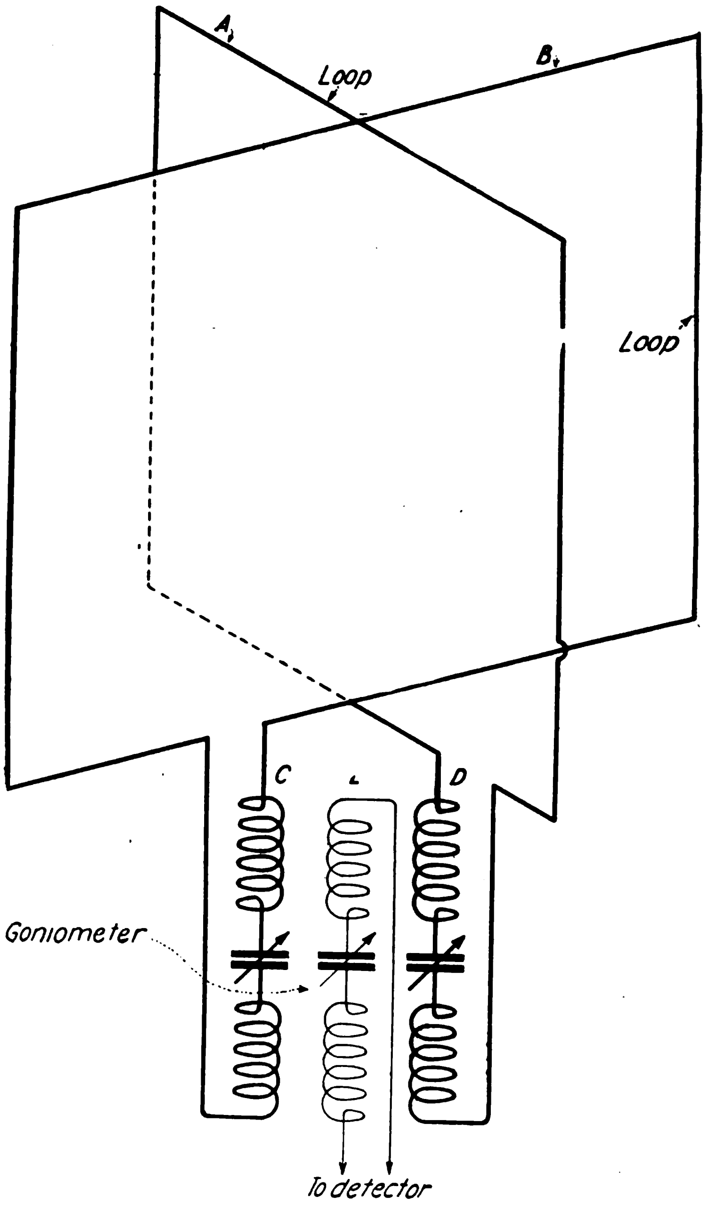


Figure 5—Fundamental circuits of an experiment involving the use of two loop antennae, connected to a receiving set to determine if the static currents could be balanced out while the signaling currents were retained. The test proved fruitless and served to indicate that the electromagnetic waves responsible for static currents are heterogeneously polarized; that is, the axes of the oscillators producing them assume all possible angles in space and the highly damped waves resulting therefrom are propagated perpendicularly to the earth's surface

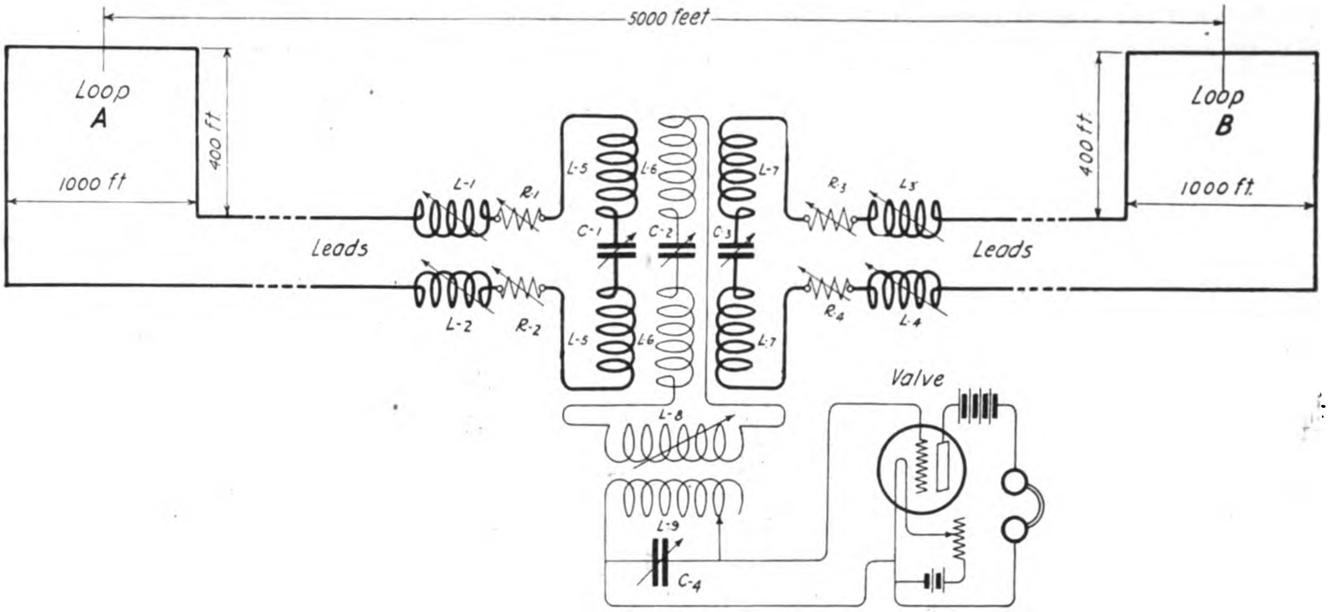


Figure 6—An early form of Weagant's system for eliminating static interference showing two single turn loop antennae spaced 5,000 feet apart. Each loop was 1,000 feet long at the base and 400 feet high. The leads from each loop were connected to the primary coils, L-5 and L-7, of the radio goniometer which were coupled to the secondary coil L-6. By rotating L-6, a position was found where the static currents neutralized and the signal currents were retained. This apparatus and antennae permitted the reception of signals from stations in Europe under conditions of static interference which with ordinary receiving apparatus and antennae would render reception impossible.

L-5, broken at the center point for connection to the variable condenser C-1. The coil L-7 connected to the loop B is similarly connected. Both L-5 and L-7 are coupled to the secondary coil L-6 which is broken at its center to include the variable condenser C-2.

The arrangement of the three coils at the receiving station was similar to that employed in the Bellini-Tosi goniometer shown in figure 7, wherein the rectangular frames L-5 and L-7 are stationary and the rotating frame L-6 is mounted on a vertical axis so that it can be rotated within the resulting magnetic field.

It may be well to describe here the preliminary procedure of adjustment: The coil L-6 is first placed in inductive relation with L-5 of loop A and the incoming signal tuned to maximum intensity. Next, coil L-6 is placed in inductive relation with L-7 of loop B, which circuit is also tuned to maximum signal intensity. Both loops are then connected in and coupled to the coil L-6 which is turned on its axis to receive the maximum induction from both L-5 and L-7. The two primary coils produce a resultant magnetic field which acts upon the rotating coil somewhat after the principle of the radio goniometer.

HOW THE STATIC ELIMINATOR WORKS

An explanatory diagram of the system of figure 6 appears in figure 8. Here the two closed circuit loops of figure 6 shown as A′ and B′ are coupled to a common secondary coil L-3 of the receiving apparatus which is installed in a station placed between the loops. The vertically propagated static waves are indicated by the *downward arrows* above the loops and the advancing signal waves which, in this diagram, are assumed to pass from left to right, are represented by the arrows A, A, A, A.

If static waves are propagated vertically, it is clear that they act upon loops A′ and B′ simultaneously and consequently electro-motive forces of equal intensity are generated in both loops and the static currents resulting therefrom flow in the same direction in each loop, as indicated by the single pointed arrows. For purposes of illustration, we have assumed that the static currents flow clockwise in the two loops as shown in the diagram. The current in loop A′ flows downward through the coil L-1 and that in loop B′ upward, through the coil L-2. The two currents will therefore neutralize and consequently none of the static current will flow in the coil L-3.

It now remains to be seen how a useful part of the energy of the signal wave is retained. From figure 8 it is evident that the signal wave acts upon the loop A′ before arriving at the loop B′; and we may assume, for the purposes of illustration, that the arrows A represent the progressive movement of the advancing wave. As the wave motion progresses and the positive half acts upon the loop B′, the negative half of the wave is acting upon loop A′. We will assume that, at a particular moment, its polarity is such that in loop A′ the static current and the signal current pass in the same direction through the coil L-1. The signal and static currents must therefore flow in opposite directions in the loop B′; and inasmuch as coils L-1 and L-2 are coupled to L-3 in such a way that the static currents oppose and neutralize, the signal

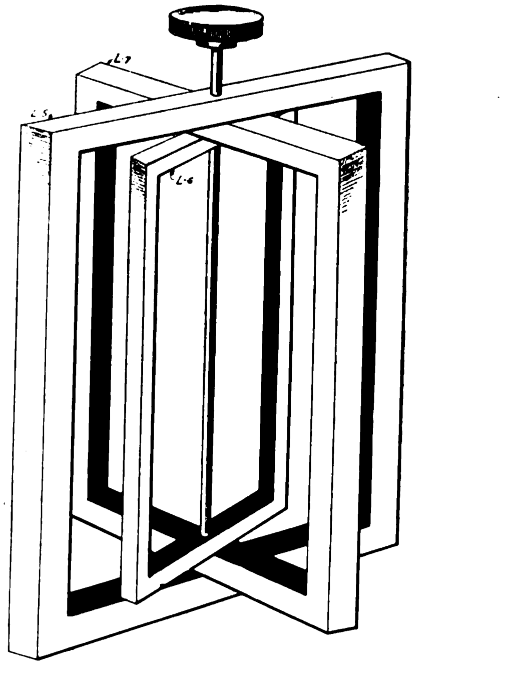


Figure 7—Fundamental construction of the radio goniometer used in the Weagant receiving system. Coils L-5 and L-7 are mounted at a right angle and the coil L-6 may be rotated in the resultant magnetic field

currents must build up in phase and accordingly affect the oscillation detector connected to the terminals of the coil L-3. The principle, of course, holds good when the negative half of the signal wave acts upon B′, and the positive half on A′.

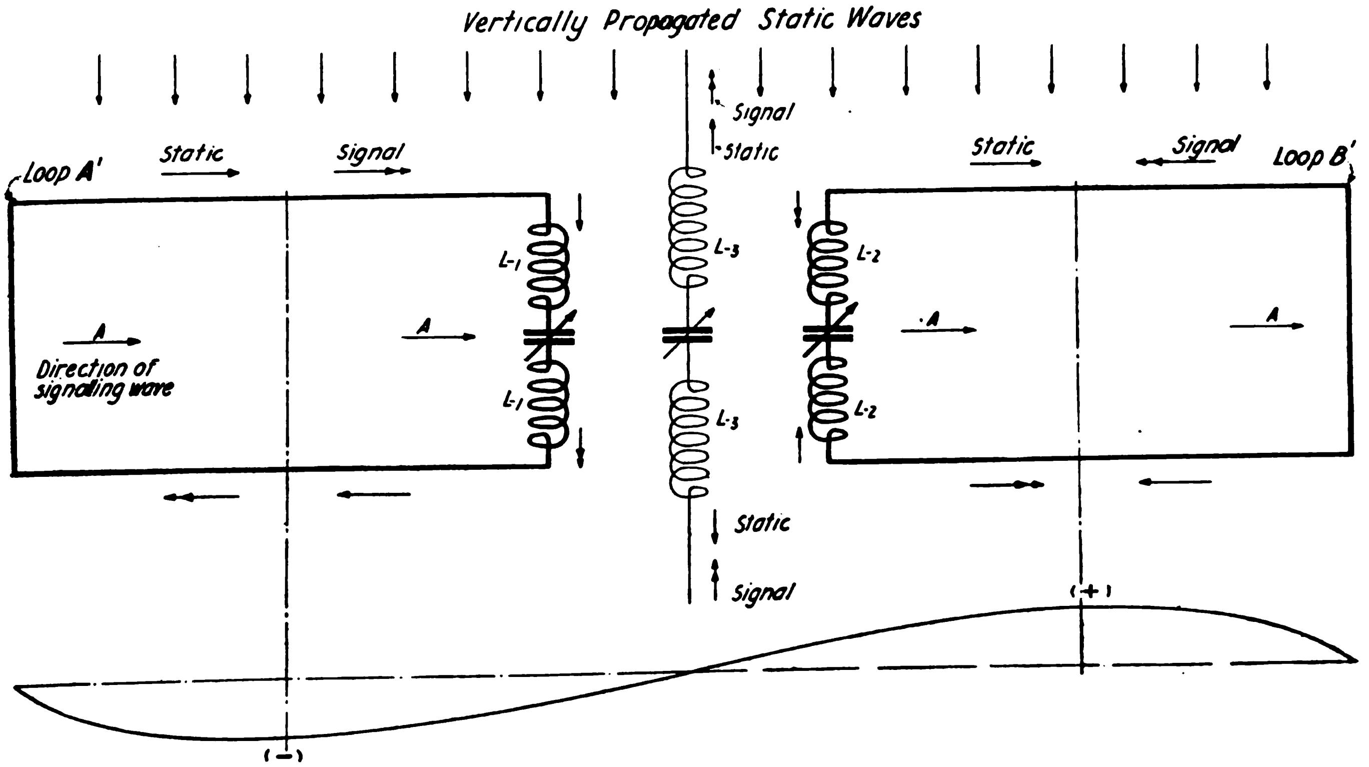


Figure 8—Explanatory diagram of the Weagant static eliminator. Loop A′ is connected to the primary coil L-1 of the goniometer; loop B′, to the second primary coil L-2. Both primaries act upon coil L-3 which rotates in the resultant magnetic field. The vertically propagated static waves act upon both loops simultaneously and the resulting static currents, as shown by the single pointed arrows flow in the same direction in both loops. The static currents flowing in the coils L-1 and L-2 may be made to act oppositely on the coil L-3 and therefore neutralize. On the other hand, the positive half of the signaling wave is assumed to act upon loop B′ and the negative half on loop A′. In loop A′, the signal current and the static current flow in the same direction, but in loop B′ they flow in opposite directions

Since coil L-3 is coupled to L-2 and L-1 in such a way that static currents neutralize it follows that the signal currents must combine. If the two antennae are spaced one-half wave length from center to center, the E.M.F.'s generated in the coil L-3 by the signal currents, will be in phase and the resultant will be the arithmetical sum of these two E.M.F.'s. If the loop separation is equal to one-quarter wave length then the E.M.F.'s will be 90 degrees apart and the resultant E.M.F. will be 1.4 times that of the individual E.M.F.'s; that is, they combine in quadrature. It is not essential that the effective spacing of the loops be one-half wave length; for one antenna can be employed for a considerable range of wave lengths provided one is willing to sacrifice some of the signal current at wave lengths other than that for which the loops give one-half wave length separation. It is evident that the Weagant system can be used in connection with any type of oscillation detector so far devised, and that the operation of the system as a whole is based on a fundamental principle never before utilized in radio communication

The foregoing may be stated in another way by saying that the static waves arrive at the two aerials at the same time, while the signals arrive at the two aerials at different times. Therefore the static currents in the two loops at any instant are in phase and the signal currents are out of phase by an amount depending upon the effective spacing of the two loops in respect to the wave length being received.

The magnitude of the E.M.F.'s generated by the signal waves will always give a resultant depending upon the effective separation of the loops; that is, the distance from center to center of the loops. If this separation is one-half wave length, the E.M.F.'s generated in the coil L-3 by the signal currents from loops A′ and B′ will be in phase and the resultant is therefore equal to the arithmetical sum of these two E.M.F.'s. If the loop separation is equal to one-quarter wave length, then the E.M.F.'s acting on the coil L-3 will be 90 degrees apart and the

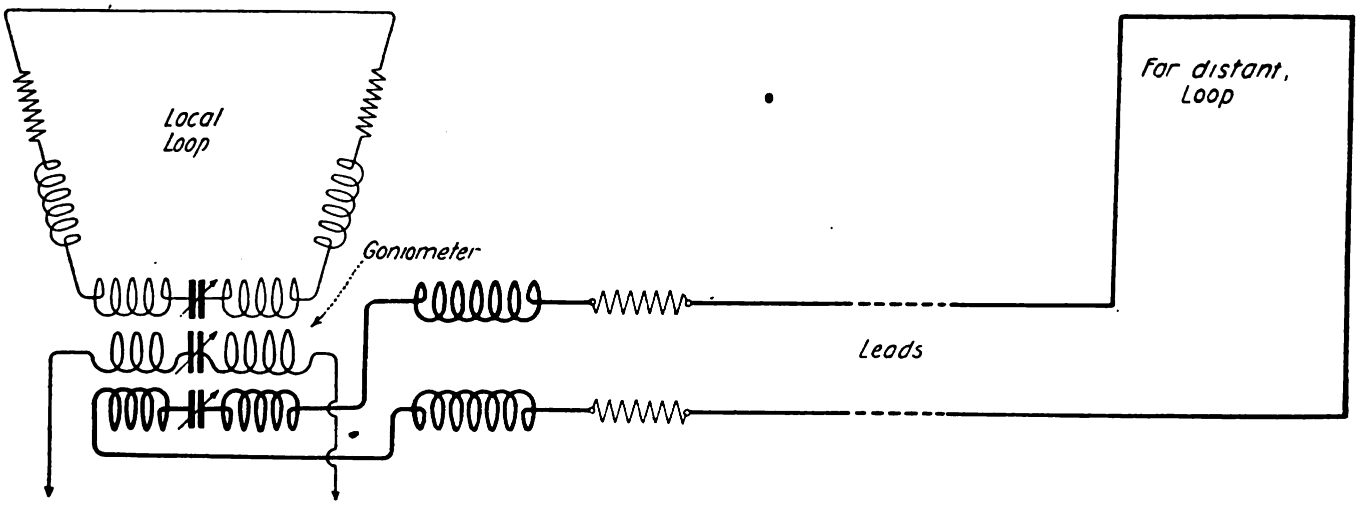


Figure 9—Circuits used in one of the early experiments conducted by Weagant wherein a small closed circuit loop was balanced against a far distant loop. This experiment at first gave a better static balance with a loss of signals and helped uncover the fact that the long low leads extending from the distant loop to the receiving station acted as an antenna, picking up both static and signals which under some circumstances were found to flow in opposite directions. This circuit was abandoned in favor of that shown in figure 6

resultant would be equal to 1.4 times that of the individual E.M.F.'s; that is, they combine in quadrature.

It is clear that the most effective separation for maximum signals is one-half wave length, and, therefore, from any particular wave length, the effective spacing of the loops should be selected to meet the above mentioned conditions. This, however, is not strictly essential in practice. One antenna can be employed for a considerable range of wave lengths provided one is willing to sacrifice some of the signal current at wave lengths other than that for which the loops give one-half wave length separation. This, therefore, is not an objection to the commercial application of this discovery.

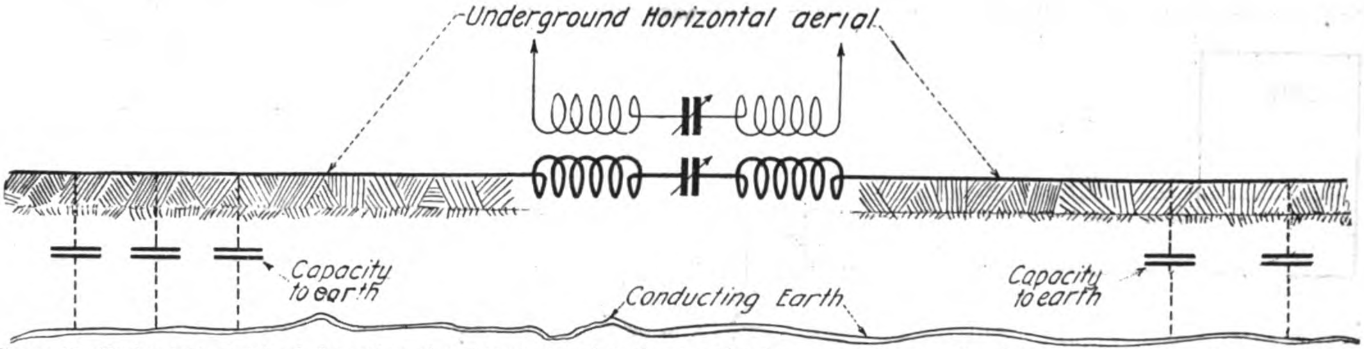


Figure 10—Explanatory sketch of the action of underground aerials showing that because of the capacity of the horizontal wires in respect to the earth, these antennae act as the closed circuit loops of the Weagant system

Now, if the theory advanced by Mr. Weagant concerning the vertical propagation of static waves were not correct, the results described could not be secured; for, if the apparatus in the receiving station was adjusted so that the signal currents combined vectorially and in accordance with the effective aerial separation, then the static currents would combine similarly, and therefore, the entire system would show the same signal to static ratio as a single loop. Since the experiments proved that the static currents do not combine but are annulled, while the signal is retained, the theory of vertical propagation of static waves is well sustained. However, as Mr. Weagant remarked, if this theory is not correct, it is at least certain that the static waves operate on a sufficient area of both loops, simultaneously, to produce the desired balance described.

In accordance with the principle of the invention, the two loops should preferably be symmetrical in every respect. Controlling appliances permitting proper adjustments to be obtained are shown in figure 6. They consist of the loading inductances, condensers and variable resistances therein indicated.

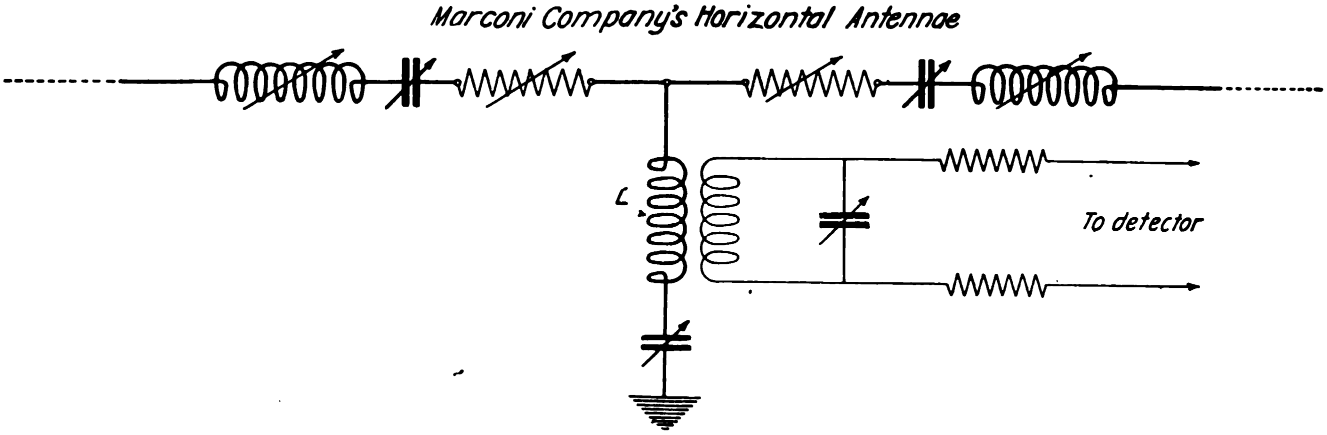


Figure 11—An early experiment conducted by Weagant in which two horizontal aerials were coupled to a detector circuit through a tuning transformer to determine if a reduction of static interference was possible. This and the circuits in figures 12, 13, 14 and 15 following, were found to give an appreciable reduction in static, but not of sufficient magnitude to permit continuous long distance wireless reception

Some practical results obtained with the system portrayed in figure 6 were reported as follows: Signals were received at Belmar, N. J., from Nauen, Germany, 6,000 and 12,000 meters; Clifton, Ireland, 5,600 meters; Carnarvon, Wales, 14,000 meters; Elivese, Germany, 9,600 meters; and Glace Bay, Nova Scotia, 7,600 meters.

Mr. Weagant observed that whenever the circuits were so adusted that static disturbances were cancelled or reduced to a minimum, the signals received on the two loops combined, as might be expected from the spacing between them and the wave length of the incoming signal.

It is evident that the spacing between the loops in the diagram of figure 6 is slightly over one-quarter wave length for the wave of 6,000 meters used by Nauen, Germany, during some of the tests. In the case of the 6,000 meter wave, the resultant signal was approximately 40% greater than that due to either aerial alone, while in the case of Carnarvon, at 14,200 meters, the spacing was equal to only 1/9 of the wave length and the resultant signal was materially less than that due to either loop, which was to be expected. The system shown in figure 6 permitted reception from Nauen, Germany, throughout the months of July and August and during the worst static periods of the day. Grinders, of such intensity as to render the signals unintelligible by ordinary receiving apparatus and antennae, were eliminated to such a degree that continuous reception from foreign stations was possible. Other observations, through continued use of the circuits of figure 6, established the fact that the heavier the static disturbances were, the more perfect was the balance that could be secured; with a consequent greater improvement in static reduction to signal ratio. This, as students of wireless telegraphy will agree, is a very desirable characteristic.

A very interesting but erstwhile elusive phenomenon met with in the system of figure 6, was the fact that the long low horizontal leads picked up static and signals as well as the far distant loops, and until this feature was thoroughly worked out, the results obtained seemed to indicate that the farther apart the loops, the less perfectly could the static currents be balanced, and also, the converse.

One experiment, seemingly supporting this erroneous belief, made use of a far distant loop, connected to the receiving apparatus through long low horizontal leads, and another loop with short leads erected at the receiving station, as in figure 9. This arrangement was found for the time being to give somewhat better results than that in figure 6, and the improvement was found to result from the more perfect balance thus secured, in spite of the loss of signal.

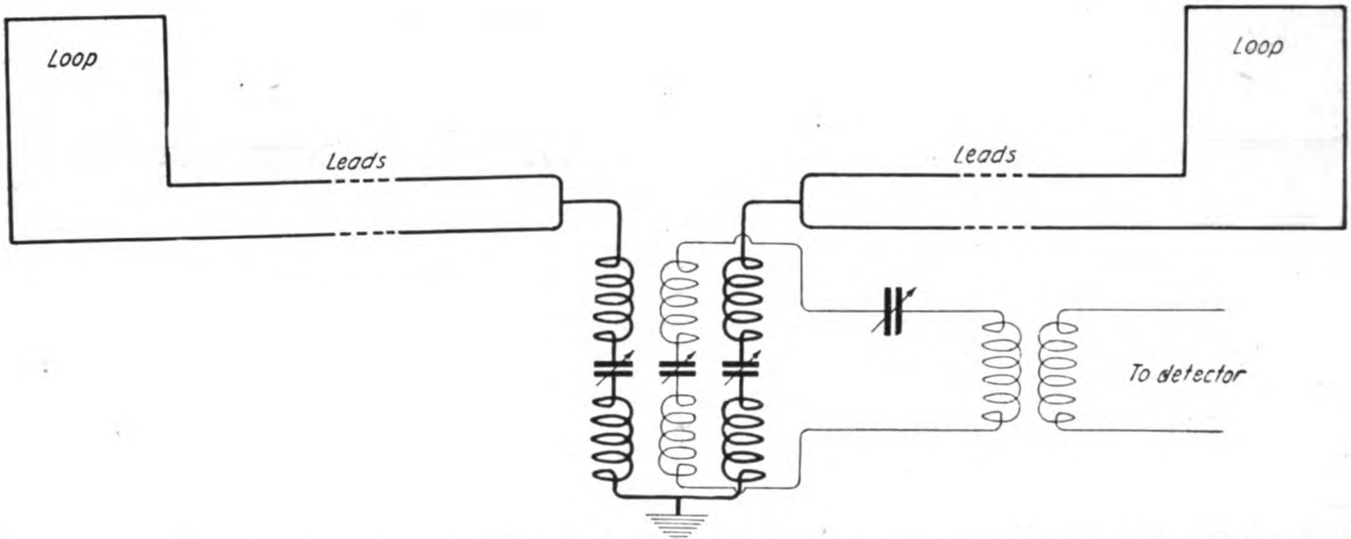


Figure 12—One of Weagant's early experiments in which the leads of two closed circuit loops were connected together, both aerials being coupled to a common detector circuit

However, as mentioned above, it was discovered later that the horizontal leads of the two loops as in figure 6, picked up some of the static and signal energy and, as a result, the static currents in a set of leads and in the loop tended to flow in the same or opposite direction. Adjustments that were made in the circuit shown in figure 6, to balance out static currents in the loop, before this fact was recognized, caused the static currents in the leads under some circumstances to add; but the simple expedient of placing reversing switches in the circuits solved the problem.

The results thereafter obtained with the Weagant system were found to be better with the use of greater rather than less effective separation, by an amount proportional to the separation.

It was observed that, in all arrangements employing two closed circuit loops connected to a central receiving station by long horizontal leads, local tuning of each loop was necessary. This was not a very convenient procedure with aerials 3 miles apart, for it became necessary to station an operator at each loop and to inform him, by telephone, what adjustments were to be made.

Underground and Surface-Ground Horizontal Aerials

The low horizontal aerial for radio reception was first used by Marconi. An antenna of the same type employed by Weagant in the spring of 1914, at New Orleans, gave a distinctly better signal to static ratio, than the large earthed aerial. Later comparisons with a loop aerial showed the two to be substantially identical in that respect.

One important deduction resulting from these tests was the fact that the long horizontal aerials laid under ground, on the surface of the ground, or suspended above the ground, may act as a loop aerial. Because of the capacity to earth (as shown diagrammatically in figure 10) a return path for the currents exists between the ends, which effectively completes the circuit.

It has been noted particularly that, as the distance between the ground and the horizontal aerial is increased, its action becomes more nearly that of an ordinary antenna; and that, because it is then not in the most effective position relative to the incoming signal to collect the maximum of energy, the signals are less in strength than would be secured with less spacing.

Quoting Mr. Weagant:

"The usually accepted explanation of the working of the horizontal aerial is that the wave front of the signal wave is tilted forward and that consequently there is a component of electric force in the direction of its length. It is to be noted, however, that under some circumstances such an aerial may be acting equally well as a loop. An aerial of this type is shown, in figure 10, lying on the surface of the ground and it is evident that by virtue of its capacity to the true conducting earth, a return path between its ends exists and, therefore, it is a form of loop; which method of consideration will account for many of the observed facts, such as its directivity, in a satisfactory way. It will also account for one observed fact which the usual methods of explanation do not account for, namely, that when an aerial of this type is laid on the ground, or buried underneath it, its effectiveness as an aerial does not increase indefinitely with length, but rapidly reaches an optimum value dependent on the circumstances obtaining. This can readily be accounted for under the present hypothesis by the fact that as the length

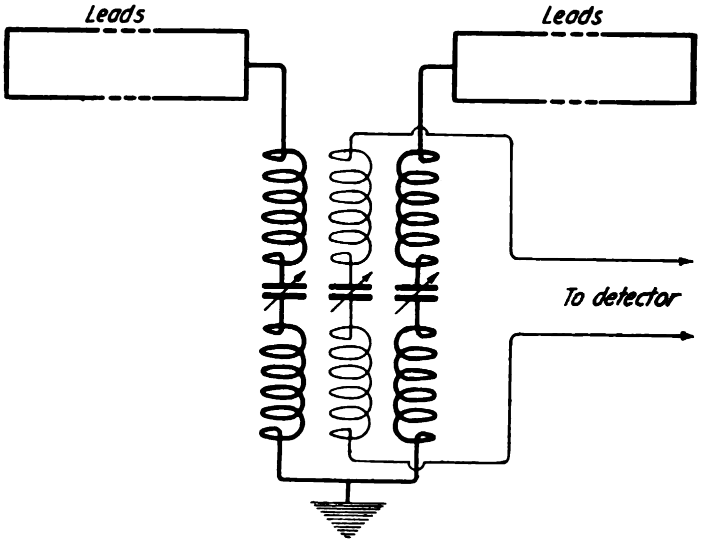


Figure 13—Circuits of an experiment wherein the leads of the Weagant loop antennae were employed as low horizontal aerials, both being coupled to a common detector circuit through a goniometer

increases its capacity to earth increases and at some point becomes sufficient to close the loop.

"As this capacity increases, however, the currents originating in this increased length have various paths in which to flow, one of which includes the receiving apparatus but others are through the capacity to earth between the conductor and the receiving apparatus, and the larger this gets the greater is the proportion of the currents originating in the ends of this aerial, which are diverted and do not flow through the receiving apparatus. This method of considering such an aerial is further supported by the fact that the greater the capacity per unit of length which exists between the conductor and the true underlying earth, the shorter is the maximum length which can be used to advantage. This capacity is a maximum, of course, when the aerial is actually buried in the ground or under water, becoming less when the wire is run on the surface of the earth and still less when the wire is suspended at some height above the earth, tests having shown that wires suspended some 10 feet above ground can be used up to some six miles in length, the signal increasing with length; that a length about one-half of this is effective when the wire is laid on the ground and of approximately 2,500 feet when the wire is placed under brackish water.

"I have also found that as the distance of such an aerial above ground is increased, its action becomes more nearly that of an ordinary antenna, and that therefore on account of its position relative to the incoming signal, it becomes less effective in collecting this signal energy."

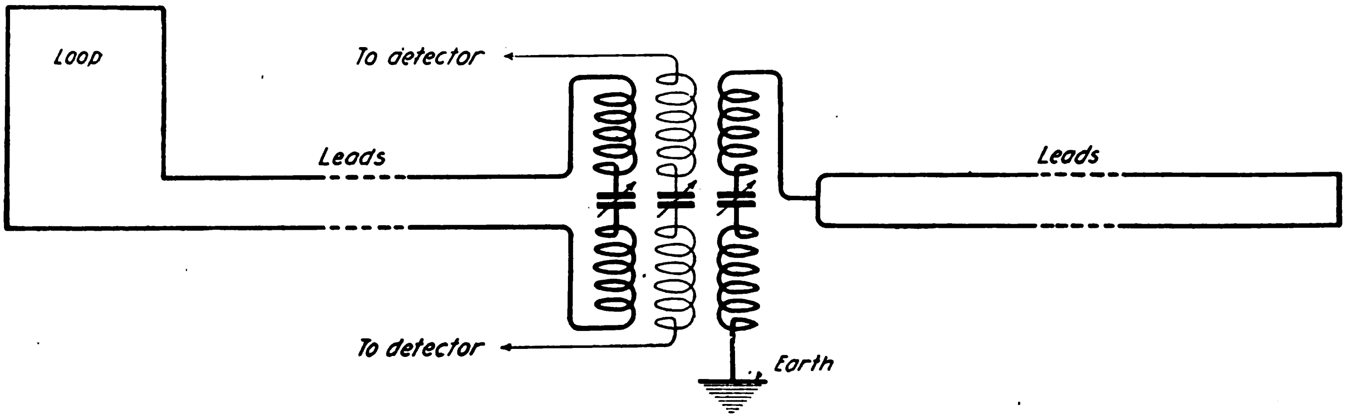


Figure 14—The circuits of an experiment wherein the horizontal leads of one loop were balanced against a second loop used in the regular way but not connected to earth

length to the height is unusually large. It follows that the aerial which is pointed in a direction away from the transmitting station is a much better receiver of the signal energy than the aerial which runs in a direction toward the transmitting station. Both aerials, however, pick up the same amount of static. The two aerials, therefore, may have a very marked difference in their signal to static ratio, and this effect will add to the effect resulting from their phase separation when this separation is small. At times, this constitutes a factor in the results obtained. While figures 11 and 12 show direct coupling at the coil L, any of the well known methods such as electrostatic, inductive or resistance couplings may be employed.

Mr. Weagant finds that this principle operates in all of the arrangements shown in figures 12, 13, 14 and 15. Figure 12 shows the connections used in an experiment in which the loop leads were connected together and each loop converted into an ordinary aerial tuned to earth. In figure 13, the leads were disconnected from the loops and their ends joined, thus making them horizontal aerials tuned to earth. In figure 14, one loop is used in the normal way and balanced against leads of the other loop tuned to earth. In figure 15, one loop is connected in its normal way while the other one is arranged as an earthed aerial. In all methods where an aerial tuned to earth is employed, it was found that the counterpoise aerials gave the best all-around results, although fair results were obtained with all the foregoing arrangements.

In addition to the foregoing connections, other variations in the circuits were also tried.

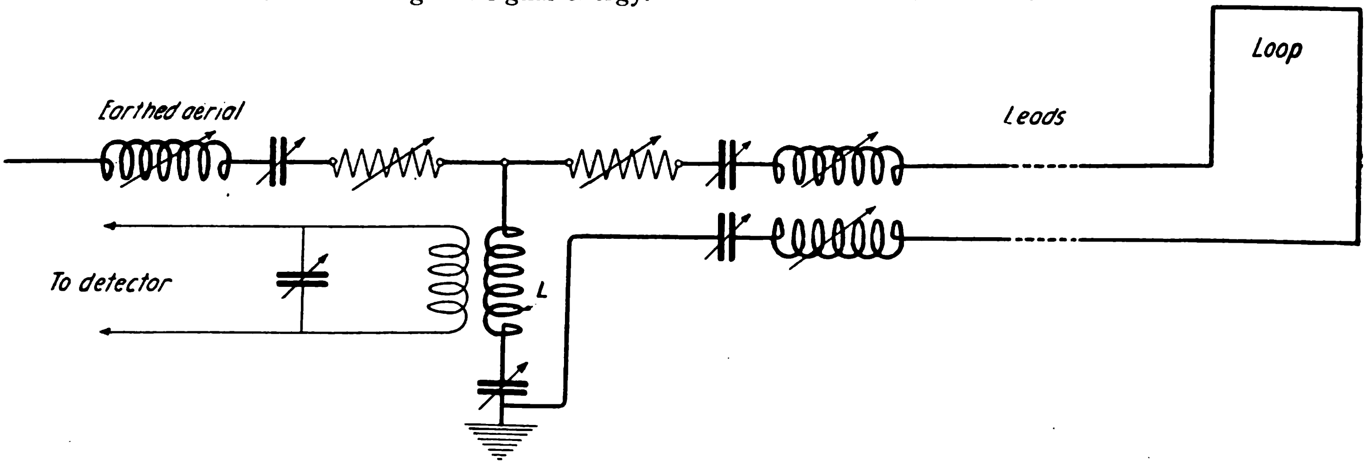


Figure 15—The circuits of an experiment wherein one of the loops in Weagant's system was connected in the regular way and balanced against an aerial tuned to earth

At an early date, at the Marconi station at Belmar, N. J., additional experiments were made by Weagant with the antenna shown in figure 11 and other combinations. It will be noted that the arrangement shown in figure 11 consists of two Marconi aerials of which the ratio of the

Elimination of Interference by the Weagant System

A discovery of vital importance in connection with the looped antenna of the Weagant system was the fact that it constitutes, as a whole, a uni-directional receiving antenna; that is, signals arriving from one end of the loop can be tuned in, while an interfering signal from the opposite end can, by proper phase adjustments, be tuned out.

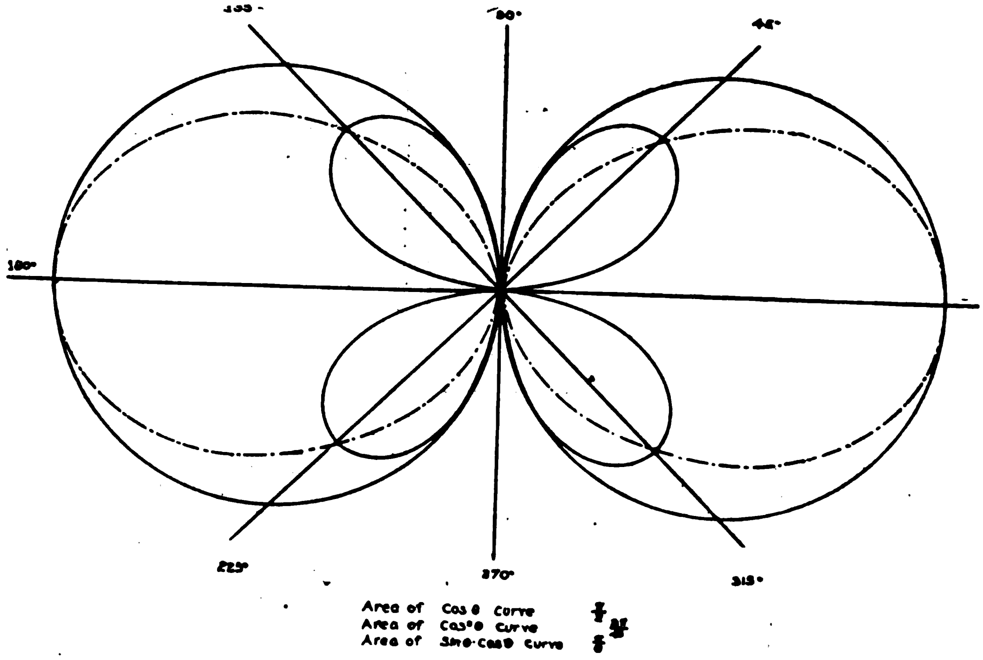


Figure 16—Reception curve of the Weagant system utilizing two-loop antennae

When the looped antenna system is adjusted to annul static of the "grinders" type, the system has a reception curve of the form shown in figure 16; its equation, is, v = V cosine², while that of the single loop is the cosine curve. The directional effect in this case is materially greater than with the single loop.

By shifting the phases of the currents in the loop antennae, the reception curve becomes that of figure 17. Between $\theta = 0$ and $\theta = \Pi$, the curve is a cosine² curve while between the angles $\theta = \Pi$ and $\theta = 2\Pi$ the curve is a sine-cosine curve, when the loops are ¼ wave length apart. This curve indicates maximum reception in one direction and zero reception in the opposite direction, with a considerable reduction of signals in the third and fourth quadrants. The line of zero reception can be swung at will through the third and fourth quadrants by alteration of the phases of the currents in the two loops, so that interference from any station arriving in either quadrant can be annulled, while reception is maintained from signals arriving in the first and second quadrants.

Mr. Weagant pointed out that advantage can be taken of this property to eliminate static interference if the static waves happen to come from a direction other than that from which the signal arrives. This is of considerable help when a thunderstorm is gathering in the vicinity of the station. Although the most effective spacing of the loop to obtain this uni-directional characteristic is one-quarter length, a general order of the result is obtainable with any spacing between the loops. The process of adjustment for obtaining one-way reception is quoted from Mr. Weagant's paper as follows:

"Suppose that the two loops of the system are one-quarter wave length apart and that the desired signal arrives from right to left; then the currents in the left-hand loop are 90 degrees behind those of the right-hand loop, if the circuits are accurately tuned, and they will add in quadrature. Next, suppose a signal arrives from left to right; then the currents due to this signal in the left-hand loop are 90 degrees ahead of those in the right-hand loop and therefore also combine in quadrature. Then currents due to both signals exist in the common receiving circuit.

"Suppose now, the phases of all currents in the left-hand loop are shifted forward 90 degrees; then the currents due to the desired signal in this loop are shifted around until they are in phase with those from the right-hand loop, while the phase of the currents due to the interfering signal in this loop, and which were previously 90 degrees ahead of those due to the right-hand loop, are now 180 degrees ahead of those in the right-hand loop, so that they oppose and neutralize. Because of the unusual characteristics of the aerial used, this shift in phase is readily accomplished by a small adjustment of the condenser in the loop circuit. If the interfering signal is not in line the right amount of phase shifting can be made to take care of it, and this general order of result is obtainable to some extent with any spacing between the loops, although one-quarter wave length is best. The reception of Carnarvon's signal, 14,200 meters, through the powerful interference of the 200 kw. Alexanderson alternator at New Brunswick, only 25 miles away, working at 13,600 meters, has been an everyday performance of the system, while at the same time preserving a good static balance. All forms of the arrangement described have capabilities of reception through interference, these capabilities varying with the type of aerial employed, the loop aerials and the horizontal aerials giving similar curves."

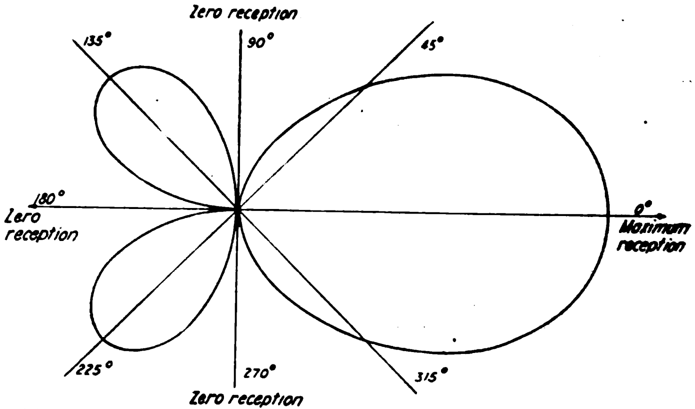


Figure 17—Reception curve of the Weagant system showing the uni-directional characteristic which may be obtained by proper adjustment of the phases of the currents in one loop. Maximum reception is obtained in directions extending through part of the first and second quadrants and minimum reception in the third and fourth quadrants. The line of zero reception may be swung through the third and fourth quadrants at will, by proper phase shifting

(To be continued)

My Experiences in the War

Second Instalment of the Personal Narrative of a Pioneer in Aircraft Wireless Who Was Wounded and Captured in the Attempt to Stop the Hun Invasion

By Captain Gordon Adams
South Lancashire Regiment

(*Continued from the February Issue*)

IN addition to wireless telegraphy, the experimental flight dealt with photography, signaling, bomb sights and instruments. Besides wireless as a means of communicating with the ground other methods of signaling were experimented with. The earliest and simplest method of communicating was by means of dropping written messages in weighted bags. Fairly successful results were obtained with a powerful searchlight fitted in front of the nacelle of a "pusher" type machine. Transmitting messages in Morse by means of releasing from a box large and small amounts of soot or color to represent dashes and dots, did not prove a success.

Photo: Press Ill. Svce.

This skilfully engineered dug-out and the almost luxurious mess hall for officers forms a marked contrast to the early days of the war which Captain Adams describes, when he lived in a shallow field trench and was without food for 48 hours

In addition to my other work I was given the job of producing an equation for determining the trajectory of an aerial bomb; if one takes into account the varying resistance of the air due to its change in density at different altitudes, and the effect produced by the state of the barometer, the resultant final equation becomes very complex. Numerical values of coefficients of resistance depending on the shape of the bomb had to be obtained experimentally by dropping a selection of bombs from captive balloons and timing their descent to the ground. This part of the work I did not care much for as I know of no more unpleasant sensation than that which is experienced in a captive spherical balloon on a gusty day.

In conjunction with my work on bomb trajectories, I designed a bomb sight which, in addition to its ordinary functions, made allowance for the drift of the machine caused by side winds. Many details have since been greatly improved in bombing range finders, and for that reason a description of my early sight might be of interest. The backsight and foresight were carried on a brass rod about a foot long. The rear end of this rod was attached to another rod mounted horizontally between to fixed uprights, with the rod left free to revolve about its longitudinal axis. The foresight end of the sight rod was attached by a sliding device to a bar which stretched transversely across a ring which was free to turn inside an outer ring. These two rings with the transverse bar could be moved fore and aft on slides, varying with them the foresight.

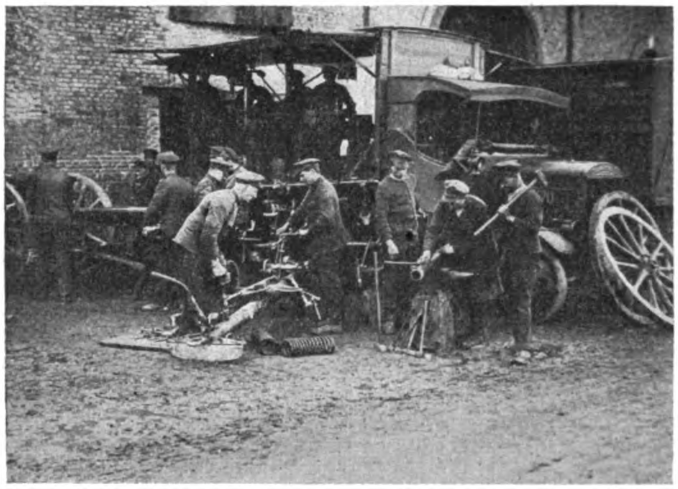
The method of setting the sight was as follows: First, ignoring the wind, the transverse bar was placed in a fore and aft position and the foresight brought to its centre, by means of the sliding attachment. Then the whole system of rings, transverse bar and foresight were moved forward on the slides according to a scale graduated for different heights. The foresight was then moved along the transverse bar to allow for the strength of the wind, and finally the transverse bar and inner ring were rotated inside the outer ring to allow for the direction of the wind.

The wind scale was constructed on the principle of the slide rule, the two factors being time of fall of the bomb and strength of the wind.

While at Farnborough, I acquired the greatest admiration for the test pilots of the Royal Aircraft Factory, whose job it was to test any new and untried type of machine. As aviation then was in its infancy and a great deal about stability had yet to be discovered, their work was attended by the greatest risks. One of these pilots—a close personal friend of mine appeared to have nerves of steel. I have known him to crash and completely pulverize a machine, and then, when he had scarcely cleared out from under the wreckage, to take up another machine straight away, without even waiting to smoke a cigarette. His method was effective, but a trifle rough. I recall that on one occasion when flying at Farnborough his engine gave out and he was just unable to reach the aerodrome; in fact, in his glide he hit the top of a tree in the grounds of a neighboring convent. I am told that the language to which he gave tongue very nearly resulted in the departure of the Sisters of the convent to a part of the country far removed from flying grounds. Leaving aside the potential value of so ready a vocabulary, I am sure that this pilot would have done great things in the war had he not had the misfortune to be taken prisoner in the very early days.

It has often struck me as remarkable how in some cases the most trivial mishap will end fatally for the pilot, while in other cases the most fearsome looking crash will result in nothing more serious than a few bruises. I saw, in the spring of 1914, a collision between two machines at a height of about 1,000 feet, resulting in both machines nose diving straight to the earth. Although the pilot of one machine was killed the aviator in the other was not even temporarily knocked out; in fact when I got to the spot I found him walking about. The subject of accidents brings to mind a somewhat extraordinary coincidence.

On July 20, 1913—I was then at the Central Flying School taking the military aviation course—a discussion of flying accidents came up during the course of a conversation which I was holding with my most intimate friend in the R. F. C. He remarked to me, I recall distinctly, that he wondered if he and I would both be alive in a year's time. On July 20, 1914—a year, to the day—he was killed in a Henri Farman biplane at Gosport.



British Official Photo

Mobile workshops followed the British army into the field at an early date, enabling repairs and re-assembling of all equipment to be done without loss of valuable time

About two months before the declaration of war the entire military wing of the R. F. C. concentrated on Salisbury Plain. The wing then consisted of 9 airplane squadrons, either complete or in the process of formation, the officer personnel being about 120. It seems to me to be one of the greatest achievements of the war, that from this nucleus was created a flying service numbering its officers and airplanes by tens of thousands.

The work of the R. A. F., as the air service was known when the R. N. A. S. and R. F. C. amalgamated, is even more remarkable when one realizes the meager supply of equipment available at the start and the total lack of any experience with the airplane as an implement of war.

It is interesting to note that at the commencement of hostilities "stunting," particularly "looping," was a court martial offence. Furthermore, in August, 1914, nothing had been done in the way of aerial gunnery. A month before the war I returned to my regiment and tried to change over to the Naval Wing of the R. F. C., which at that time was in the process of being very considerably enlarged. I hoped in that way I should see more of aviation as a whole and have a wider scope. However, I was doomed to disappointment, just as I had got everything practically fixed up. The war broke suddenly and in answer to telegrams which I hurriedly sent to London I was told that for the present all officers would have to remain where they were.

Accordingly I sailed for France with my regiment on August 13, 1914.

* * *

Before proceeding with the narrative which begins with our departure for France, it would be well to give a brief outline of the composition and organization of the British Army at the outbreak of the war. Each infantry regiment consisted of a depot, 2 regular Battalions, 1 or 2 Special Reserve Battalions, and 2 to 4 Territorial Battalions. Of the two Regular Battalions one was always stationed at home and the other abroad, generally in India. The work of the Special Reserve was to supply reinforcements, while the primary duty of the Territorials was home defence. The Depot unit collected recruits and put them through their initial training. When they finished their training, they were sent to the home battalion and generally remained in that unit for another two years. At the end of that time they were drafted to India, where they saw several years service, finally returning home to go into the Reserve or to complete their service with the home battalion.

With the declaration of war the reserves were called up in sufficient numbers to complete the establishment of the home battalions. It was these home battalions which constituted the British Expeditionary Force. When mobilized for war these men had generally averaged about 7 years service with the colors. The officer personnel was brought up to establishment by officers drawn from the Special Reserve. The British Expeditionary Force consisted of 6 infantry divisions and 1 cavalry division. Artillery, Engineers, and other special auxiliary troops were included in the Infantry Division. This was the force of trained fighters which William Hohenzollern was pleased to term the "contemptible little British Army."

The B. E. F. immediately started mobilization on the declaration of war on August 4, 1914; nine days later we embarked at Southampton. At that time I was senior subaltern of my battalion. The secrecy with which we left England has since struck everyone as very marvelous. I believe I am right in saying that the only person who witnessed our departure was a diminutive boy scout who had brought a message to the quay for the colonel. Daybreak on the morning of August 14 saw us anchored off Havre waiting for the tide. At noon we started off again on a 70 mile trip up the Seine.

As we were entering the mouth of the river we were very nearly sunk, owing to one of the men accidentally letting go the anchor. We pulled up with a jerk and were very nearly run down by another and much larger transport which was immediately in our wake. The whole way up the Seine we were greeted by crowds of cheering Frenchman, and finally, about 7 in the evening, we disembarked at Rouen and went into camp about 3 miles outside the town. The second morning following, at 6 a. m., we left Rouen by a train which took us to a place called Aymeries. I was fortunate in being billetted with the right half battalion, for we put up in a very nice old-fashioned farm house, the owner of which provided a most excellent dinner; many toasts were proposed and some stirring speeches made. It was a night to live in memory.

Early the next morning we marched to a small village called Marbaix. Here I recall seeing a veteran of the Franco-Prussian war of 1870 who had had the whole of his nose, eyes and forehead blown away, but appeared to be perfectly fit and happy. He wore a French Legion of Honor. My billet at Marbaix was comfortable but I could have wished for something better in the way of atmosphere. The building was a cheese factory.

Photo by Int'l

This Loening monoplane, equipped with a 300 horsepower Hispano-Suiza motor, made a speed of 145 miles per hour recently and attained a height of 25,000 feet in 43 minutes. Its monoplane predecessors described in this article had no elements of safety and very uncertain control

We stayed in Marbaix until the 20th, while the rest of the troops came up. The weather was glorious and I was quite beginning to enjoy war. With the arrival of our remaining units we marched on to a large town called Avesnes where we were given a tremendous reception. The mayor met the General at the outskirts of the city, and drank champagne with him at the head of the column. As we continued our march through the town the ladies showered tens of thousands of flowers upon us. It was vastly amusing to see elderly and very dignified officers riding along profusely bedecked with floral tribute that clung to all parts of their anatomy, including neck and ears. The night was spent at St. Hilaire and the march continued at 4, the next morning. That day we covered a very long distance over French cobbled roads and in stifling heat, and arrived in the evening at a town called Feignies. Another long march the next day landed us at Frameries. It was here that we first heard the enemy's fire and saw a few German prisoners being brought in, captured by our cavalry screen.

British Official Photo

From the day of the outbreak of hostilities the water supply was always a problem. The illustration shows a detail from Britain's "contemptible little army" drilling a well

That night I spent guarding divisional headquarters.

Early the next morning we again marched off—this time, only a few miles—to be rebilletted in a village called Ciphy, a short distance from Frameries. No sooner had we allotted the men to their billets, however, than the order came to "fall in." Rumor had it that we were going to dig some trenches in the neighborhood. But on marching over the crest of a small hill we found ourselves about 2 miles from Mons and virtually in the midst of a battle. We hastily deployed and as rapidly as possible dug some small, field trenches.

About 4 o'clock the enemy started shelling our position, and kept the fire up until nightfall. Our own guns were barking a reply to the enemy's fire from our immediate rear. During the evening I remember sharing my last tin of bully beef with a brother officer. It was the last food I had for 48 hours.

When darkness fell the surrounding country presented a most lurid picture. Every building of any size at all was in flames. Immediately in front of us was a burning church, but all the fire and smoke seemed to be confined to the interior of the building, the only thing that showed that it was on fire was the fact that the spire was glitteringly white hot. I slept something less than an hour and a half during the night.

An hour before dawn, the order was passed down the line in a whisper to stand to. Everything was deathly still. Gradually, the faintest glimmer of dawn appeared, and I could dimly discern about 400 yards to our front a line of ghostlike figures moving about. I whispered to my men to fix their sights at 400 yards. It got lighter. The figures appeared to have approached a bit nearer. Still I held my fire and readjusted the men's sights. Nearer and nearer they seemed to come; the suppressed excitement was intense. Then came the moment when I thought the time ripe to open fire. Peering through the half-light, objects somehow seemed suddenly to take more definite form. My row of supposed Germans was a row of tall thistles waving about in the wind!

With sunrise, the enemy resumed his shelling, and about 9 o'clock an infantry mass attack was launched against us. Numerically, the German strength was six men to our one. I made a hasty estimate of the situation. Our position was roughly as follows: A and B companies were on the right, C and D companies on the left, but pushed forward about 100 yards to the crest of a small rise in the ground. My company was B.

Companies C and D took the brunt of the attack when it came, swiftly and viciously. They put up a very gallant resistance but were driven out of their positions with the bayonet. Through this success, the Germans were now occupying the positions of C and D companies, only 100 yards from companies A and B. Company A was ordered to retire after the remnants of C and D had got back, and my company was left to hold the Germans until the first company had completed its retirement.

When it came my company's turn to retire we had nobody to support us with a covering fire. In order to get back to the rest of the battalion we had to traverse some 600 yards of absolutely open country, flat as a billiard table and in full view of the enemy. It was an uncomfortable prospect, but in covering that ground I received one of the greatest surprises of my life. We had heard much about the efficiency of the German war machine, and we naturally expected that they would be able to shoot with tolerable accuracy. Yet during the whole of that 600 yards retirement the enemy were shooting at us with rifles and scores of machine guns, but their shooting was so execrable that out of a target consisting of 240 men they only succeeded in hitting four!

As we fell back it was plainly evident that it was quite hopeless to entertain any idea of defeating the Hun outright, owing to his overwhelming majority in numbers; our instructions were to continue retiring, holding on to successive positions until the last moment and contesting every inch of the German advance. Thus we were to gain time for reinforcements to arrive. We took up position after position. Halte, Blaigemes, Beaudigines and other villages were successfully evacuated. All this time the weather was intensely hot and we had no food and practically no sleep. During 112 hours I had 6 hours sleep.

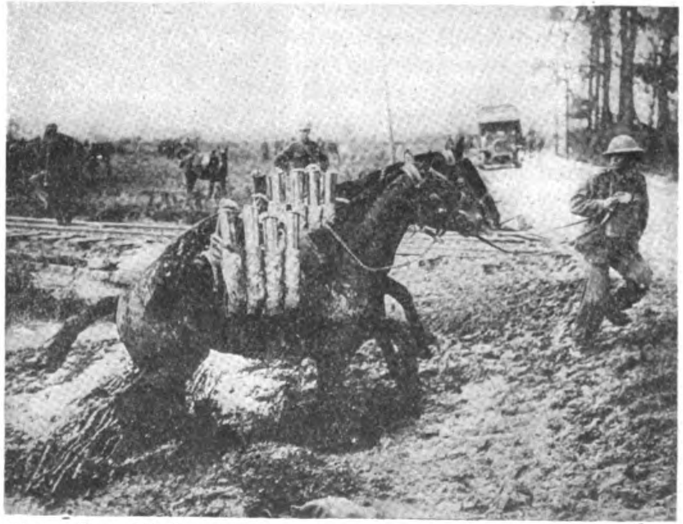
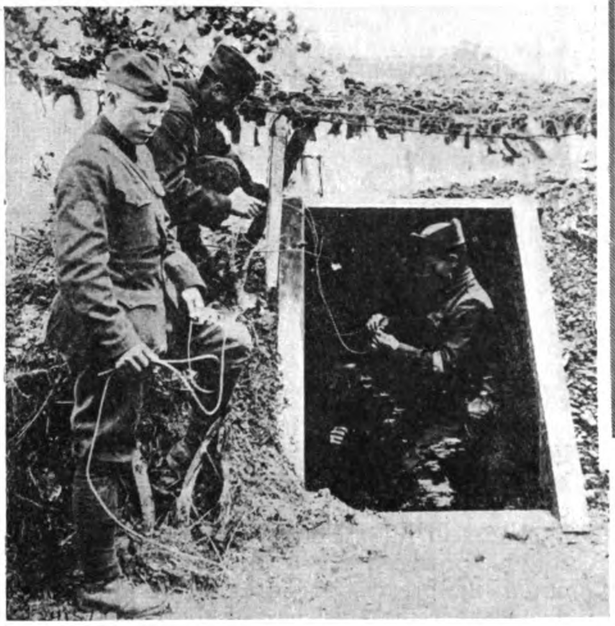


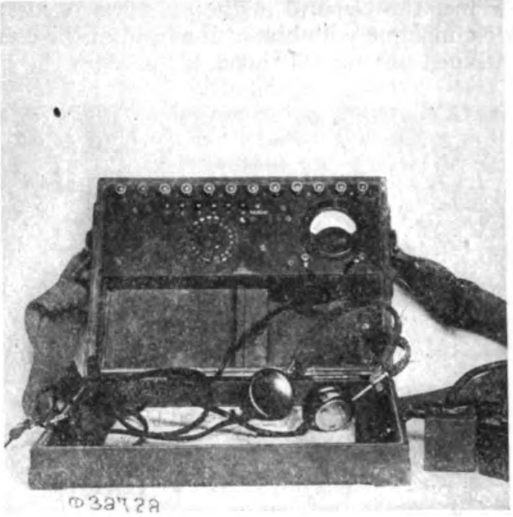
Photo: Press Ill. Svce.

Falling back before the first onslaught of the Germans, as described by the author, was a process made increasingly difficult by the sticky, clinging mud which impeded progress everywhere

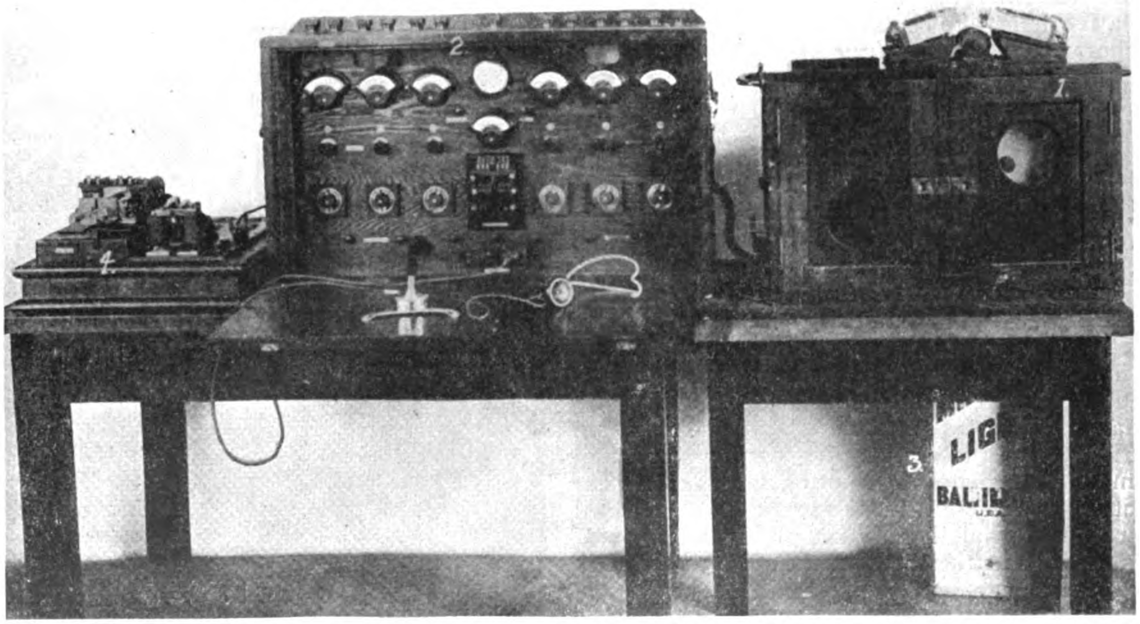
(Continued on page 26)

To the right: A signal Corps official photograph of the light microphone set used in trench eavesdropping operations which have been so widely discussed by home-coming soldiers. The apparatus can be used for either local underground or surface listening and the observer may be placed any desired distance from the point of detection





To the left: A photograph taken in St. Laurent, France, on August 20th last, showing members of the 102nd Field Signal Bn. (formerly the 1st Bn. of the New York National Guard), laying wires from General O'Ryan's dugout. This huge dugout was divided into two rooms, one for General O'Ryan and staff of the 27th Division, and the other for telegraph tables and telephone switchboards. The structure, the entrance to which has a camouflage screen, was built by the 102nd Engineers, formerly the 22nd Regt., N. G. N. Y., commanded by Brigadier General Cornelius Vanderbilt, one of America's most noted millionaires



A complete view of the American sound ranging set used for locating enemy obscured guns and batteries; it was by means of this apparatus that one of the big Hun guns which was shelling Paris was located
Photos by Signal Corps, U. S. A.

Wireless Communication with the Far East*

By W. A. Winterbottom

Traffic Manager, Marconi Wireless Telegraph Co., of America

FEW subjects today are of greater interest or importance to the American business man than improved and largely increased facilities for international communication. Without the opportunity for cheap and rapid communication between nations, commercial and social progress is seriously retarded, if not made impossible.

The Far East has long been in close telegraphic touch with Great Britain, and the channels of communication today between continental Europe and the Far East are far more numerous than those we possess. Less than twenty years ago our telegrams for the Far East were sent across the Atlantic to Great Britain, and thence forwarded either across northern Russia or through the Mediterranean on the way to Japan and China. The rate per word was very high indeed, much as $3.00 per word from New York City to Japan. Japan at that time could hardly have been further from the United States.

Then the Commercial Cable Company, with farsighted vision, laid a cable from San Francisco to the Far East, connecting up the Pacific Islands on the way. Our Far Eastern commerce at that time was quite small; it required considerable courage and faith in the future to literally sink from ten to fifteen million dollars in the Pacific Ocean.

The Pacific Cable brought the Far East much nearer to us than ever before; for in the telegraph fraternity, countries are near or distant according to the number of transmission points intervening.

Prior to the advent of the Pacific Cable at least twenty transmissions were necessary to send a message from New York through Europe to the Far East, which did not help to make cipher messages more readable.

The Pacific Cable reduced the number of transmissions to three or four. If we could still further reduce these retransmissions, to that degree would we bring the United States and the Far East closer together.

This problem has at last been solved by wireless telegraphy, and direct and instantaneous reliable communication by radio is now possible between the Far East and the United States. It is only a few months ago that one of Japan's leading statesmen, familiar with the progress of long distance wireless communication, stated in a public address "The Pacific Ocean, which has so long widely separated our two countries, is now no broader than a river." Japan could hardly be nearer.

The fascinating story of long distance commercial wireless has unfortunately been interrupted by the great war. The military and naval authorities have taken over temporarily all wireless services for uses much more important than the requirements of commerce. The United States Navy has found the high power stations of the Marconi Company extremely valuable for European communications and a few weeks ago submitted a bill to Congress providing for the permanent ownership of all wireless stations in this country. To have so monopolized high power radio communication would, I feel sure, have been a serious loss to the commercial world, but I am glad to say that the Congressional Committee unanimously voted against the Government ownership plan.

When peace is officially consummated and we are permitted to operate our stations commercially, a low priced, rapid and reliable means of communication will be available for use to Great Britain and the Continent, Scandinavia and Russia, the Far East and Australia, and a little later Argentina, Brazil and other South American countries, Mexico and the West Indies. It is a large program, but the greater part of it is already completed.

The first, and perhaps most interesting, long distance commercial wireless service was inaugurated in 1912—only seven years ago—between Great Britain and Nova Scotia. It is a little out of date now in its equipment, but it continues to render a satisfactory service between Great Britain and Canada, and at the present time some of our American newspapers are receiving considerable quantities of European news over this route in competition with the cable services.

Other and much larger wireless stations erected by the Marconi Company are located in New Jersey, Massachusetts, California and Hawaii. Another powerful station is now under construction just outside Buenos Aires.

The New Jersey stations will communicate directly with Great Britain and the Continent. The Massachusetts stations will communicate directly with Norway for messages to and from that country, Sweden, Denmark and Russia. The complementary stations in Europe are completed, and are only awaiting the proclamation of peace to change from their military character to that for which they were primarily designed.

The stations in California have already rendered excellent service to Hawaii and the Far East, and will do so again as soon as they are released to us.

Our Navy Department has been making very extensive use of the Marconi high power stations for communications with Europe, working at all times directly with stations in England, France and Italy.

In view of the fact that some people today doubt the reliability of radio communication as compared with submarine cable communication, it is interesting to quote the words of Commander S. C. Hooper—head of technical bureau of the United States Naval Radio Service—who recently testified before the Congressional Committee just referred to. Speaking of the Marconi high power stations and the service they have rendered the country during the past eighteen months, he said: "They are the stations which will compete with the cables for the handling of messages overseas, and I am not making any new prophesy when I state that the competition will be keen. Since the war has been on we have established reliable communication across the ocean and we never miss a message from the other side."

You will recall that the cable service to which the Commander compared the radio service, is over fifty years old in development and experience, while we are only seven. Further evidence of the position now occupied by wireless is the recent order of Mr. Burleson directing that all Government messages for Europe, except those for some special reason routed via cable, should be forwarded by wireless. Since important and confidential Government communications may now be handled by wireless, we may rest assured that a new era of communication is at hand, the possibilities of which we can only conjecture.

And now to mention the service to the Far East.

In 1914 the Marconi Company completed high power stations near San Francisco and Honolulu to compete with the single Pacific cable, and offered its new service to the public. From the beginning, it was extremely popular with the Hawaiian business men, for they now had competition, and competition in oversea telegraph service is a fine thing. It usually results in cheaper rates, a more expeditious service, and greater satisfaction to the public. For almost fifteen years the citizens of Hawaii were required to pay for every word sent to San Francisco—it mattered not whether it was plain language or code, important or otherwise—at the rate of 35 cents per word. This rate was never changed, and the number of telegraphic communications between Hawaii and the mainland, and vice versa, was very small indeed. The Marconi service opened at 25 cents per word, a reduction of 10 cents per word, and further, introduced the popular night and week-end letters to the Hawaiians at a rate of approximately 8 cents per word.

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*An address delivered before the Japan Society in New York.

Reflect for a moment. Rates reduced from 35 cents to 25 cents and 8 cents per word. No wonder the Marconi Company has so many friends and supporters in Hawaii, that small but important mid-Pacific outpost whose Chamber of Commerce sent a representative to Washington to raise its official voice in vigorous protest at the proposal for Government ownership of all wireless services. The business men of Hawaii have had a practical demonstration of the reliability and rapidity of commercial wireless, and are urging its early resumption by the Marconi Company.

Suffice to say, that within two months the submarine cable tariff which had stood so long was lowered to the level of the new wireless tariff, and it is generally acknowledged that within two or three years thereafter the number of telegraphic communiations to and from Hawaii was increased fourfold.

The trans-Pacific wireless service was not planned to stop at Hawaii. The Far East, and even Australia, was our goal. Our Hawaiian station had been built (at a cost of approximately $2,000,000) in two distinct sections, one to work to California, the other to work with Japan, both sections to work simultaneously. But the war again interfered. The Japanese station built at the same time was taken over by its Navy Department (for Japan too was at war) and it was not until 1916 that the station was released to commercial operation nine hours per day. Nine hours per day is not a very satisfactory way of conducting a telegraph service, but it was the best we could get until peace came, when we could expect the full use of the station.

In 1916, therefore, I went to Hawaii to supervise the inauguration of the first wireless service conducted between the United States and Japan. The usual messages of felicitation were exchanged between President Wilson and the Emperor of Japan, Ambassadors and other notables, and then we settled down to commercial business.

The cable rate from San Francisco to Japan, which had prevailed for years, was $1.21 per word, with no deferred or other cheaper service. The Marconi service opened at 80 cents per word for urgent communications, or a reduction of 41 cents per word, and also offered for the first time a non-urgent service at 40 cents per word, a reduction of 81 cents per word.

The service immediately became so popular and satisfactory that some means had to be adopted to curtail the volume of business offered for transmission, as it must not be forgotten that we were restricted to 9 hours per day and that was divided into three periods. It was therefore decided to confine the service to the city of San Francisco, which is perhaps our second largest center of Far Eastern trade.

Although it was expected to utilize the Hawaiian station as a necessary relay point for Japanese messages, it was soon discovered that practically all messages transmitted from the Japanese station were received with equal facility in California, and it was only occasionally that the assistance of the intermediate station in Hawaii was required. Further recent improvements in the radio art have assured the regularity of this direct Japan-United States wireless service.

I might add that, while I was in San Francisco, several of the large Japanese steamship companies and export houses expressed their amazement at the high grade service we rendered. The accuracy of the service, due to the elimination of relay stations, was most gratifying and the economy was of course fully appreciated. The service continued to increase in efficiency and volume of traffic until April 7, 1917—the great day in our history on which war was declared upon Germany—when the Navy Department commandeered our stations and has not yet permitted us to resume commercial operations. I understand that since the armistice the Navy Department has been offering a limited public wireless service from San Francisco.

And so science has at last brought the United States and Japan very close indeed, and with the advent of freer and cheaper communication, we may confidently look forward to a constructive age of peace, goodwill and a better understanding between the once widely separated peoples of the world.

My Experiences in the War

(*Continued from page* 23)

Among the troops falling back before the German onslaught was a celebrated British cavalry regiment, of which an amusing incident is told. On one occasion, thinking that they were at last free from the enemy for a few moments, they repaired to a neighboring stream and proceeded to bathe. While engaged in this refreshing recreation the alarm was sounded. A regiment of German Uhlans was approaching. Not waiting to dress, our men seized their sabres, mounted their horses and charged—clad simply but tastefully in their birthday suitings. The Germans stopped, amazed, and then beat it for all they were worth. The redoubtable Uhlans were not sufficiently brave to try conclusions with this absolutely unknown and unheard of type of soldier.

The war always held its humorous moments; but these were rare; in the main it was ever a grim business. At about 4 o'clock on August 25th, just as we were approaching the town of Solesmes, the enemy opened heavy shell fire on us from our right flank. The men were in the last stages of exhaustion, but at the sound of fire they immediately seemed to become revitalized. We rapidly took up a position on the top of a hill immediately north of the town. As soon as we were in position there came a temporary lull in the enemy's fire; but only for a few minutes. The Hun guns very shortly reopened with a veritable tornado of shells. For about 3 hours we were subjected to this hail of high explosives. Our reply was a crashing heavy rifle fire on his gun position, and we kept it up until nightfall. When we had expended all our ammunition our instructions were to hold the position at all costs until dark, in order to give the forces behind us time to consolidate their position at Le Cateau, about 6 miles in our rear.

At 8.30 the Colonel gave orders to retire. I had covered about 100 yards and was just congratulating myself in still being alive, when a shell exploded about a yard away and blew my thigh bone to pieces. I went down like a shot rabbit; and where I fell, there I stayed.

(*To be continued*)

EXPERIMENTERS' WORLD

Experimenters are urged to submit manuscripts covering the design and construction of all types of wireless apparatus for amateur use. Such articles will receive immediate consideration and those published will be paid for at regular space rates. The scope of this department is constantly enlarging

Amateur Transmitting Panel

Improving the Efficiency of a Wireless Station

By A. R. Zahorsky, New York

IT behooves every amateur to prepare for the time when the Government will give out the order to go ahead. The design of the transmitter should be given careful consideration, for whether one is able to transmit signals 1,000 miles, or only 100 miles, with a one kilowatt set, will depend upon the mounting of the component parts, as well as upon the electrical characteristics of the apparatus. The objects of this article are: To set forth methods of eliminating certain factors which tend to reduce the efficiency of a wireless station, and to show drawings of a transmitting set which will help to illustrate the fundamental points of this discussion.

GROUND CONNECTION

The ground connection is a vital part of a wireless station. If it is poor, the effectiveness of the system is greatly diminished. The most efficient "ground" to be obtained by the amateur is a connection to the city water mains. The water pipes should not be used if the earth wire measured from the instruments to the water pipe exceeds 30 feet in a horizontal direction. In case it exceeds this length, it is advisable to construct a separate earth plate. The following table gives the resistance of different types of earth connections. The amateur should choose the best suited to his purpose, remembering that grounds of lowest resistance have the highest efficiency.

RESISTANCE OF DIFFERENT TYPES OF GROUNDS

(1)	10 lb. scrap copper set 6'—0" deep surrounded with 10 lb. coke	14.2 ohms
(2)	Copper plate 5' x 3½' set 4' deep surrounded with 2'—0" crushed coke	5.6 ohms
(3)	9' length 1¼" black iron pipe driven 6 ft. into solid earth	25.1 ohms
(4)	12' length black iron ditto	14.8 ohms
(5)	Two 9' lengths ¾" pipe set 6' deep in coke	15.2 ohms
(6)	Perforated metal cone 18" long filled with charcoal buried 6 ft. in 2 ft. of coke	14.4 ohms
(7)	Connection to city water main	0.44 ohms
(8)	1" pipe in deposit of ashes 1 ft. deep	26. ohms
(9)	1" pipe driven in 5'—0", surrounded with 16 lb. salt mixed with earth, water poured around	20. ohms
(10)	1" pipe 5'—0" long buried 12" horizontally salted and watered after 4 days	15. ohms

The resistances given are for rich black soil.

The wire leading from the instrument panel to the ground connection should be short and run as nearly vertical as possible. A No. 4 B & S stranded, rubber covered wire serves the purpose.

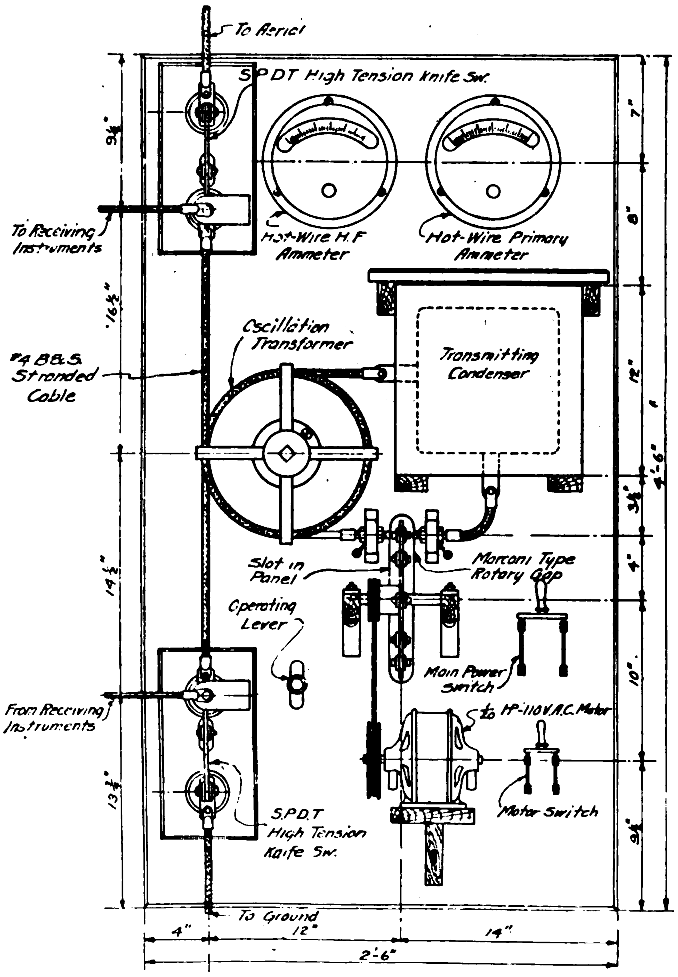


Figure 1—Front view of transmitting panel for an amateur radio station

OPERATING PANEL

The operating panel, shown in the accompanying figures 1, 2, 3 and 4, may be made of transite asbestos wood, from ½ inch to ¾ inch thick. This is the best kind of material to use, because it is cheaper than slate or marble, more easily worked and is fireproof. However, a panel of neat appearance may be built of 1 inch oak or pine boards and given two coats of floor varnish. The panel is mounted by means of wood screws on two 2" x 2" wooden uprights or on iron brackets and braced at a point 15 inches from the wall.

For switching from a transmitting to a receiving position, two single pole double throw high tension knife switches are employed. The blades as shown in the side elevations, figures 2 and 3, are interlocked by means of bell-cranks and levers, and are operated by a lever approximately 2'—7" from the floor. This places it in a convenient position for a man sitting in a chair.

The wire used for the oscillation transformer shown in figure 3 should be in size no less than No. 4 B & S stranded bare or insulated cable. If none is available, the amateur may build up an equivalent cable by twisting together 27 No. 18 B & S bare wires, or 40 No. 20 B & S wires. The smaller the wires the better will be the conductivity for high frequency currents. The conductor for both primary and secondary of the oscillation transformer are wound on crosses made of pine boards impregnated with paraffine. Both coils are supported so that they may slide back and forth on a square brass rod set into the front of the panel. The coils are 10 inches in diameter.

The condenser in the primary circuit is built up of ¼ inch glass plates 12 inches square. Half the plates are coated with extra heavy tin foil 9 inches square, applied to both sides. Terminal lags are placed on the case, one on the lower edge, the other on the side. They are preferably made of thin sheet copper. In assembling the condenser a plain glass plate is placed between two coated plates to vary the capacity. This method avoids taking taps from the helix, as is usually done and is simpler.

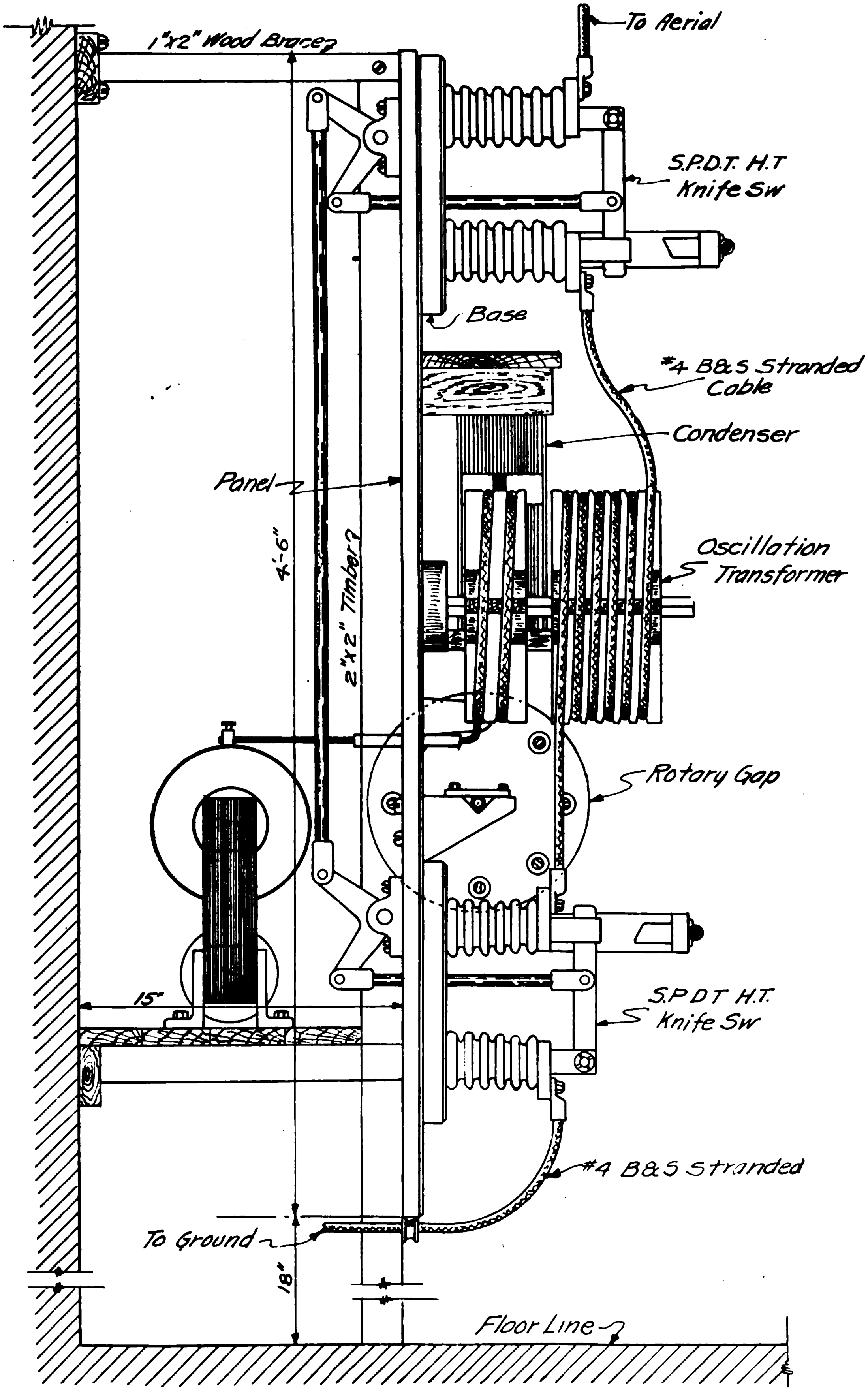


Figure 2—Left end view of transmitting panel showing single pole double throw high tension switches interlocked by means of bell-cranks and levers

The rotary gap is one of the Marconi type of dischargers. The disc is made from a piece of red fibre ¼ inch thick, 10 inches in diameter, impregnated with paraffine.

It has eight 3/8 inch brass studs spaced equally around the circumference and fastened by means of a nut on each side. The nuts are thin, being made by cutting in two with a hack saw a 3/8 inch brass nut. The pulley should be about 3 inches in diameter. The disc and pulley are mounted on a piece of 3/8 inch drill-rod 6 inches long, which serves as a shaft. The rotary gap should be driven by a small induction motor and run about 1,800 R. P. M., giving 240 discharges per second. The size of the pulley on the motor depends on the motor speed. A leather belt serves as a driving medium.

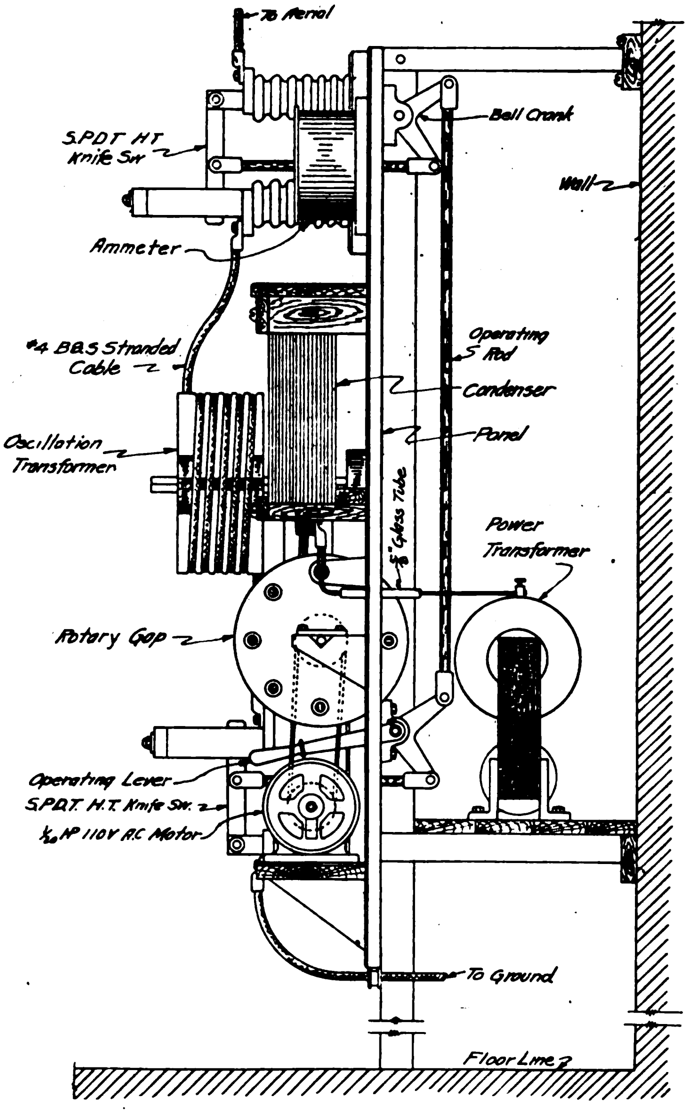


Figure 3—Right end view showing instruments and facilities for their operation

The hot-wire ammeter on the left hand side of the panel should have flexible leads with spring clips so that it may be inserted in the aerial circuit when required. The other ammeter is placed permanently in the 110-volt supply line as shown in the wiring diagram, figure 4.

The special features of this transmitter are the short leads in the oscillating circuits and the lack of sharp bends or kinks which would cause leakage at high voltages. All sharp corners on both conductor and insulators should be rounded off with a file. The insulators shown on the high tension knife switches may be porcelain or electrose, or hard wood baked dry and then boiled in paraffine. High voltage insulation is necessary.

It will be noted that there are 5 turns on the secondary of the oscillation transformer. This may have to be modified for aerials of different heights and lengths. The inductance of such a coil is given by Nagaoka's formula:

$$L = \frac{4\pi^2 a^2 n^2}{b} \times K, \text{ cms.}$$

where a = mean radius of coil = 5" = 12.7 cm.
b = overall length of coil = 3.5" = 7.89 cm.
n = number of turns = 5
K = a constant depending on the ratio of $2a/b$

Obtained from tables by Nagaoka which may be found in Bureau of Standards bulletin No. 74 or bulletin No. 169.

For $2a/b = 3.22$, $K = .412$.

Substituting these values in the preceding formula we obtain, $L = 8325$ cms.

If we insert this inductance in a "T" aerial 120 feet long and 60 feet in height we obtain a wave length of $\lambda = 203$ meters.

The inductance of the primary coil may be obtained in a similar manner making corrections for the leads from the condenser. If the coil is built to dimensions given in the illustrations, its inductance will be 2084 cms.

The capacity of a condenser used in conjunction with primary inductance L = 2084 cms. is given by,

$$C(\text{mfd}) = \frac{\lambda^2 \text{ (meters)}}{3550 \text{ L (cm)}}$$

If $\lambda = 200$ meters
$C = .0054$ mfd.

The capacity of a glass plate condenser is given by,

$$C = \frac{n K A}{4 \pi d} \times 1/9 \times 10^{-5} \text{ mfds.}$$

where n = number of plates required,
K = a constant which for plate glass may be taken as approximately 6.

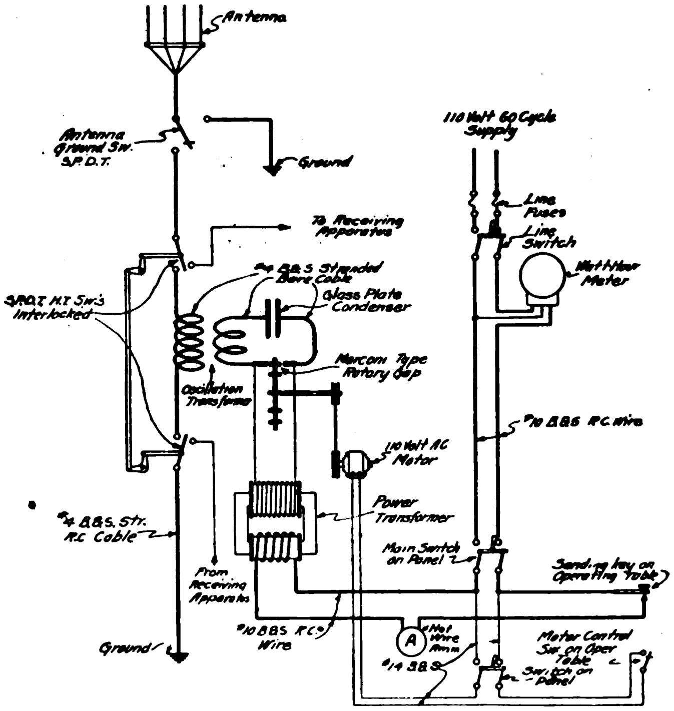


Figure 4—Diagram of connections for the panel set

A = area of the metal foil = 81 sq. in. = 523 sq. cm.
d = thickness of the glass = .25" = .635 cm.

The number of plates required then is,

$$n = \frac{4\pi d C}{K A} = 12.35.$$

We shall therefore use 13 plates and adjust the capacity by varying the distance between the plates. For the wave length of 250 meters, it will be necessary to use 20 plates.

The diagram, figure 4, does not show protective condensers. A protective unit consists of two 2 microfarad condensers connected in series. The central wire is connected to earth and the two outside wires across the power line close to the meter. A protective spark gap might also be connected across the secondary of the high voltage transformer.

The Up-to-Date Amateur Radio Station

A Station Designed to Permit Reception from all Transmitting Stations Irrespective of Type or Wave Length

By Fearing Pratt, Massachusetts

THE ideal amateur station should be designed to permit reception from all stations, irrespective of the type of transmitter or the wave length employed. The apparatus should be installed to permit the conduct of experiments to determine the best method of connection for a particular set of conditions. Such a station has many possibilities, but it may prove too expensive for some experimenters.

In order that it will not be necessary to duplicate certain parts of the apparatus which are essential to all circuits, the instruments should be assembled so that the connections are easily accessible. The principal receiving set should not, however, suffer any loss of efficiency by complicated connections and combinations of switching devices.

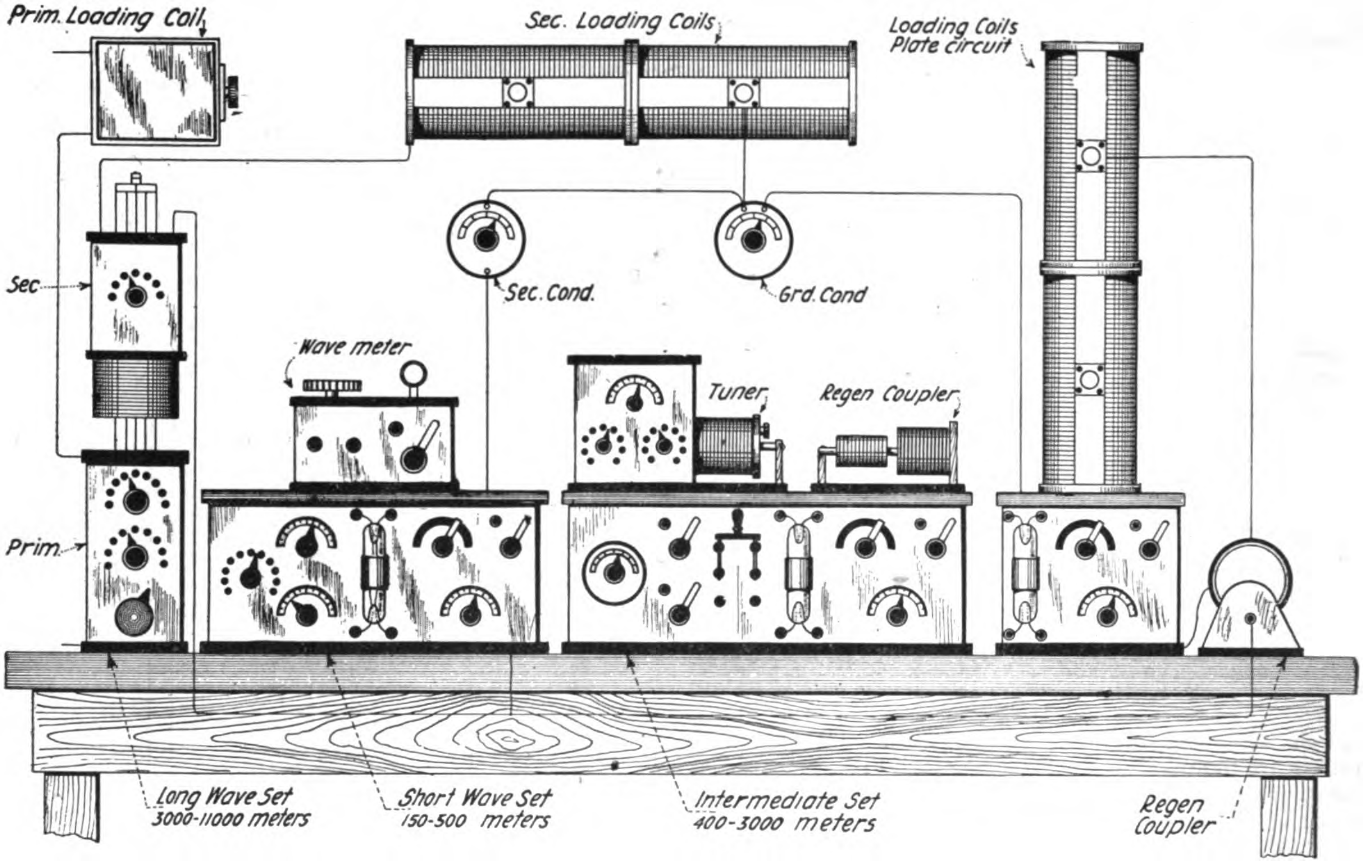

Prim. Loading Coil
Sec. Loading Coils
Loading Coils Plate circuit
Sec
Sec. Cond.
Grd. Cond
Wave meter
Tuner
Regen Coupler
Prim
Long Wave Set 3000-11000 meters
Short Wave Set 150-500 meters
Intermediate Set 400-3000 meters
Regen Coupler

Figure 1—Front view of cabinet with the secondary tuning condenser, vacuum tube controls and the necessary switches mounted in place

The station I have in mind is composed of three receiving sets with one or more transmitters. Any one of these sets may be installed without interfering with the operation of the others. An amateur is likely to be fully satisfied with his first set, but he will later install additional apparatus from time to time which gives the station the appearance of an experimental laboratory. The main set described in this article has a receiving range of 450-3,000 meters, mounted in a cabinet which is always ready for use. Two additional sets are provided to take care of the upper and lower ranges of wave lengths.

THE AERIALS

Two aerials are to be used, one for transmitting and the other for receiving. The transmitting aerial should be 60 to 75 feet long and 40 to 60 feet high, with a natural wave length of about 160 meters. A pole erected on the roof directly above the transmitting set permits a short lead-in. Six wires, two feet apart, will give the necessary capacity. This aerial is to be used in receiving stations from 150 to 500 meters and a special transfer switch should therefore be provided.

A larger aerial, running at a right angle to the transmitting aerial, is employed for receiving wave lengths above 400 meters. It should be from 300 to 500 feet long and 50 to 100 feet high, consisting of two wires. The natural wave length should be near to 800 meters. With this aerial it is possible to receive wave lengths down to, say, 450 meters with a series condenser. By appropriate loading inductances, waves up to 12,000 meters may be received.

THE TRANSMITTER

The transmitter consists of a 1 kw. transformer having a secondary voltage of 15,000 volts, connected to a 110 volt, 60 cycle, alternating current circuit. An impedance coil is necessary to regulate the current in the primary circuit. A hot wire ammeter in the primary circuit permits an approximate indication of the power consumed, since the power factor is fairly high and the line voltage remains practically constant. A good key and kick-back preventer are necessary, of course.

A rotary spark gap having studs protruding from the circumference, the studs and outer rim forming one casting, is the most suitable gap for operation with 60 cycle current. This type of rotary gap has two distinct advantages over that type in which the studs are perpendicular to the face of the disc. First, slight variations of the disc due to warping have no effect on the spark length. (The writer has not yet found any material that will not warp slightly in time.) Second, if the fixed electrodes are brought into contact with the rotating studs while in motion, no damage will be done to the disc. The motor on which the gap is mounted, must have generous bearings. It is much better to use a motor that is a little larger than necessary so that silent operation will be obtained.

A molded high voltage condenser is the best type for amateur use. It will withstand high voltage and have long life. An oscillation transformer of the pancake type is very satisfactory. If the secondary is provided with a rotating contact to permit tuning with the key closed, considerable advantage is gained.

A hot-wire ammeter is accurate enough to measure the antenna current. A thermo couple type of meter may be a little better, but its greater cost may make it prohibitive.

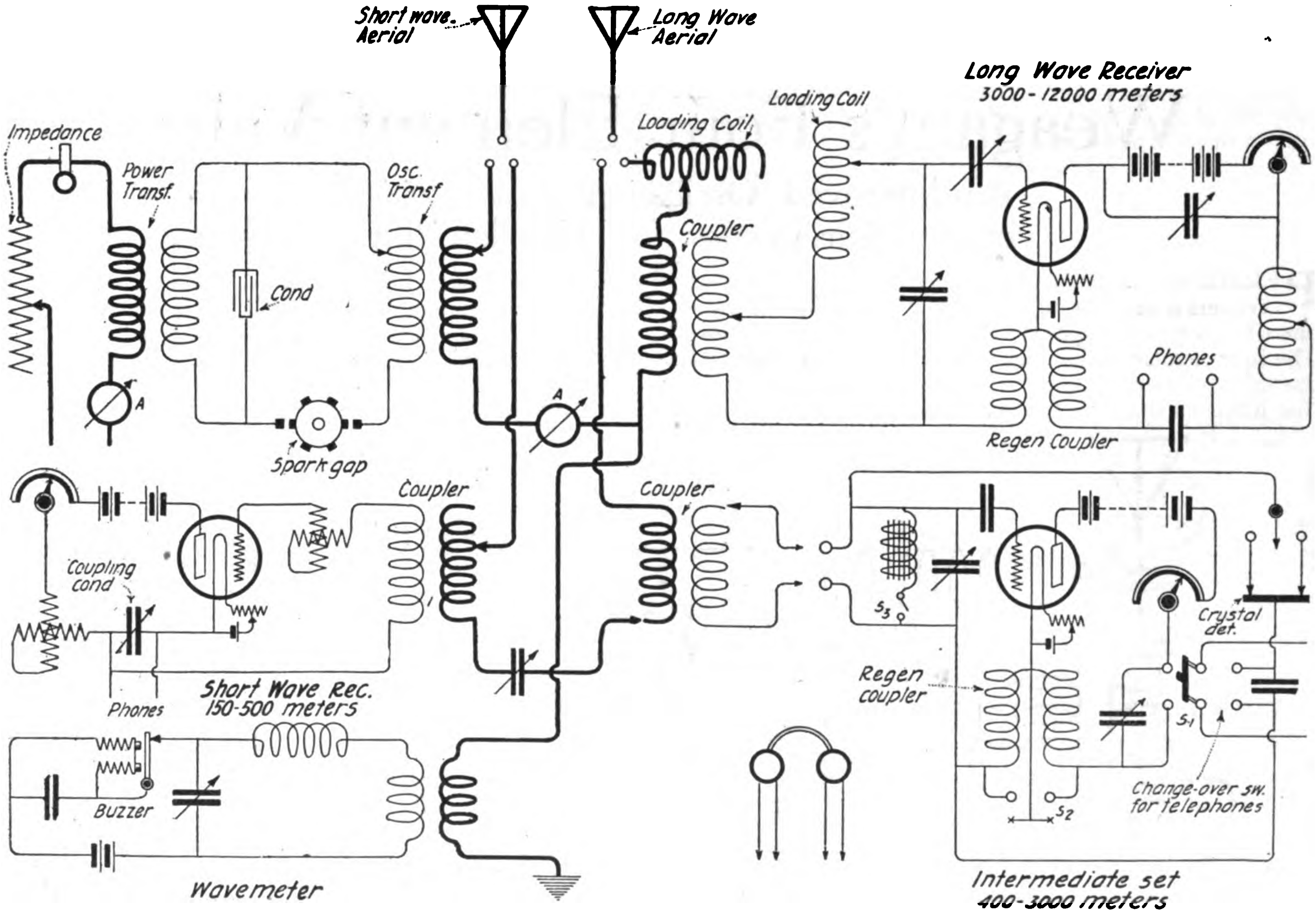


Figure 2—Diagram of connections for the receiving apparatus of an up- to-date amateur radio station

Receiving Sets

The receiving apparatus shown in figures 1 and 2 consists of three complete sets, each being provided with a vacuum tube connected in a regenerative circuit. One set is used for reception from amateur stations and has a range from 150 to 500 meters. It is connected to the transmitting aerial. The second set is the main stand-by set and has a range from 450 to 3,000 meters. The third set is used for receiving from high power stations and has a range from 3,000 to 11,000 meters, or greater.

The first set consists of a small loose coupler with a multiple point switch to vary the antenna inductance. The secondary has but one tap. A variometer is employed as a secondary loading coil; all tuning in the secondary circuit is effected with this instrument. It has been found that a secondary condenser, even if set at zero value, has too great a capacity for short wave lengths. A variometer is also used to tune the plate circuit. A plug is provided for inserting a pair of telephones or coupling the output circuit to the input circuit of another vacuum tube for amplification.

The second, or intermediate wave length set, consists of a series antenna condenser, a coupler, and a secondary circuit with a regenerative coupling. Condensers are used in the secondary and grid circuits. A double throw double pole, and a single throw double pole switch are provided. The first switch marked S-1 shifts the connections from the vacuum tube detector to crystal detectors; the second switch, marked S-2, shifts from a regenerative connection to a simple vacuum tube detector connection. Another single throw single pole switch, marked S-3, connects in an auto transformer so that the tube may be used as an amplifier for either of the other sets. The secondary circuit coils are placed in a cabinet on top of which is mounted the tuning coupler, the regenerative coupler and a series condenser. Most any loose coupler of the proper range will prove satisfactory if the inductance is changed by a multiple point switch. The regenerative control switch is located on the back of the regenerative coupler. On the front of the cabinet are mounted the secondary tuning condenser, vacuum tube controls and the necessary switches.

The third set consists of a 3,000 to 7,500 meter coupler, a regenerative transformer with a vacuum tube and loading coils of sufficient inductance to raise the wave length to 12,000 meters. The coupler is of the multiple point type, with a secondary which moves in a vertical plane. This design is economical in space and, as shown in figure 1, it is desirable that all the nearby inductances shall be perpendicular to each other. Each loading coil is built in two sections, which makes it possible to remove unused units from the circuit.

The primary loading coil is mounted on the wall to the left. The secondary loading coils are shown mounted on the wall over the main set with the secondary and grid condensers below. The tuning switches on the coupler and the secondary tuning condenser must have long handles for operation.

On the right are shown the plate circuit inductances. vacuum tube, and regenerative coupler. The output of this detector circuit may be coupled to the input of the vacuum tube of the principal set, as in the case of the short wave set. Audio frequency amplification is employed. Radio frequency amplifying circuits may be a trifle more sensitive but the slight advantage gained is lost in the complex operations that a radio frequency amplifier introduce. Copper tubing or flexible wire may be used to connect the apparatus as shown in figure 1. The apparatus in the writer's opinion, is arranged for convenience and for maximum efficiency.

A telephone headset of 1,500 ohms each is used for recording the signals. If the experimenter will run a pair of separate cords to each receiver and attach plugs at the ends he can connect one receiver to one of any two sets. This makes it possible to hold communication with another station and at the same time stand-by for a high power station. Both receivers may be plugged in on the same set if desired. Auto transformers may be installed in the long wave and short wave sets so that a detector and two-step amplifier may be added to the circuit.

A wave meter (shown above the short wave tuner) is a very convenient accessory. A small wave meter inductance may be used for tuning the transmitting set and a large inductance for tuning the long wave receiving set. Long distance stations usually have a fixed schedule and fixed wave lengths. This makes it possible to pre-adjust the receiver to the required wave length by the wave meter.

Weagant's Four Element Valve

An Improved Oscillation Valve with Increased Sensitiveness for Detection Purposes

PERMISSION has been granted to present to our readers a description of an improved oscillation valve, one of a series of types developed by Roy A. Weagant. The four element valve illustrated in figure 1, differs from the three element tube described in last month's issue in that it has an unconnected grid element G placed between the filament F and the plate P. The sensitiveness of the tube for detection purposes is thus considerably improved. External to the glass container and parallel with the internal electron stream is the electrostatic control element K, which is generally connected to the high potential terminal of the secondary of the receiving transformer. The immediate effect of inserting the element G is to give the tube a more favorable characteristic for the detection of radio frequency currents by the head telephone.

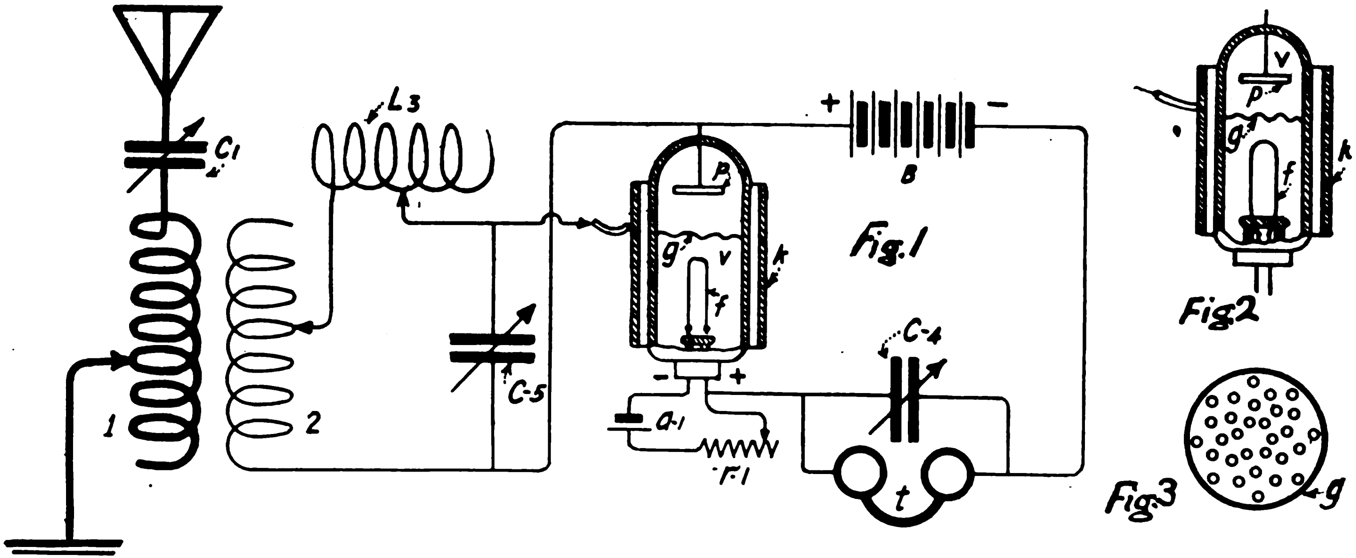


Figure 1—Simple circuit showing hook-up of the Weagant valve. Figure 2—Showing the construction of the valve. Figure 3—One form of the internal element G

According to the inventor, a tube without the element G behaves as follows: If the cathode F and the anode P are spaced far apart, the valve is very sensitive; but because this spacing requires a low potential in the anode circuit, there is a distinct upper limit of signal amplification. On the other hand, if the spacing of the cathode and anode be increased, the plate voltage may be increased with marked amplifications for strong incoming signals. Its sensitiveness to weak signals is, however, reduced. The four element tube combines the desirable characteristics of the two opposing conditions; that is, short spacing may be employed and high voltages applied to the plate circuit with consequent amplification of all signals from the weakest to the strongest. It appears, therefore, that the external element K is the essential element for impressing the received oscillations upon the electron stream, whereas element G permits operation on a favorable point of the characteristic curve.

Any of the well-known circuits for cascade audio or radio frequency amplification, or regenerative amplification, may be employed. An illustrative and simple circuit is shown in figure 2. One terminal of the secondary circuit of the receiving transformer is connected to the external sheath K and the other to the anode or plate P. Figure 3 shows one form of construction for the internal element G.

In the interests of historical accuracy, it may be mentioned that the U. S. Patent specification for this invention was filed April 5th, 1915, and granted January 7th, 1919.

A Four-Valve Cascade Amplifier for Radio Reception

EDITOR'S NOTE—Cascade amplifiers with inductive couplings and resonant circuits between tubes introduce complications which require the attention of an engineer. Because of the simplicity of the four-valve amplifier herewith described, it is especially recommended to the progressive radio experimenter. This is the forerunner of a variety of special circuits and designs that we will present to amateur enthusiasts, from time to time.—Technical Editor.

THE following is a description of a four-valve high-frequency amplifier utilizing one of a series of arrangements described by J. Scott-Taggart in one of his latest articles on valve circuits. It is a complete wireless receiving circuit and possesses the peculiarity and great advantage to amateurs and experimenters of having no inter-valve or step-up transformers. Another advantage is that all the valves, except the first, detect, rectify and amplify incoming oscillations. The first valve is only for amplification purposes. The accompanying diagram, figure 1, shows the complete circuits.

The open or aerial circuit, which has a variable condenser C-1 in series with the aerial, is coupled to the grid oscillatory circuit of the first valve. Another variable condenser C-2 is placed in parallel with the secondary inductance, and although this condenser is for tuning purposes, the inductance should be used as much as possible, and the capacity reserved for fine tuning.

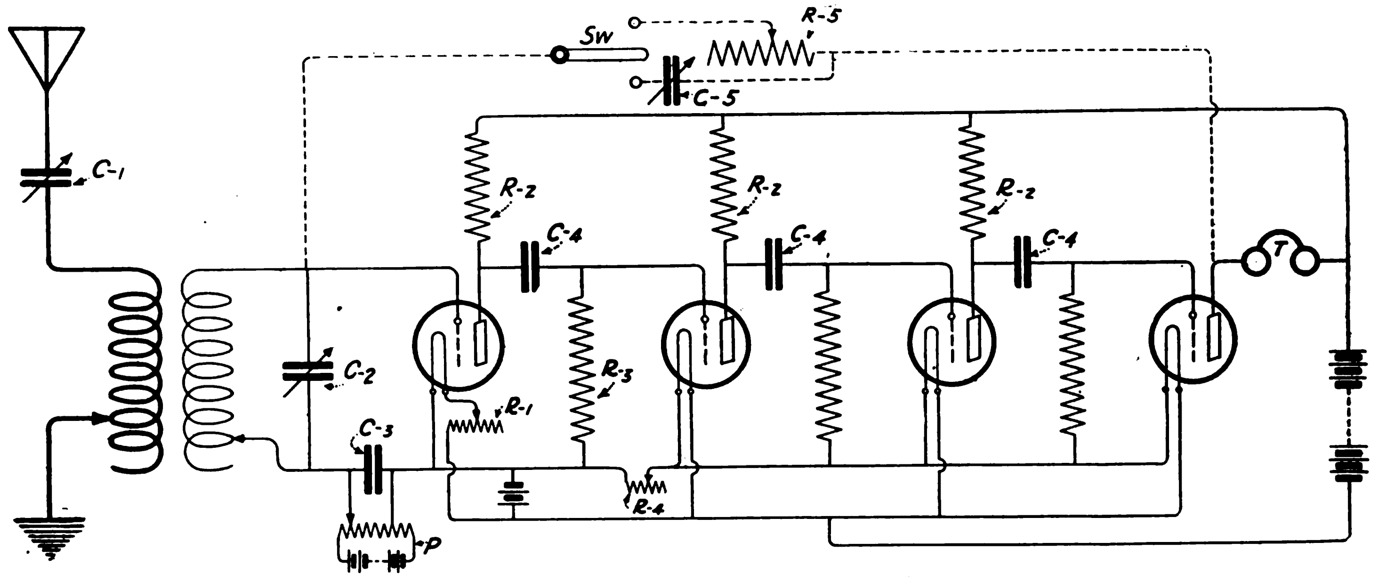


Figure 1—Diagram showing circuits of the four-valve cascade amplifier for radio reception

By means of the potentiometer P the grid potential of the first valve is adjusted to a point where best amplification of the oscillations in this circuit is obtained. The separate filament rheostat R-1 also assists in the selection of a suitable adjustment for better amplification.

A small condenser C-3 (about .004 mfd.) placed across the potentiometer allows high-frequency oscillations to pass freely. In the plate circuit is a resistance R-2 of 80,000 ohms. There are similar resistances in the plate circuit of the third and fourth valve.

The high-frequency oscillations which are reproduced in the plate circuit of the first valve are communicated to the grid of the second valve, as the plate circuit resistance R-2 offers too much resistance to the flow of such high-frequency currents. In each grid circuit except the first is a leak R-3 connected between grid and filament. The resistance of the leak is 4 megohms.

As the functions of the third and fourth valves are similar to the second, the filament current should be the same. A rheostat R-4 of 5 ohms, connected as shown, will give a uniform current to these three valves.

The high resistance R-2 can be easily made by scratching grooves, about 1 to 3 inches long, with a sharp instrument on a piece of ebonite and filling them with graphite by simply rubbing a pencil along them. Terminals should be fitted to the ends in such a way as to ensure good contact.

The telephones T, if connected directly in the plate circuit of the last valve, must be of high resistance; but if a step-down telephone transformer is used low resistance telephones will give better results. The latter arrangement is preferable.

The battery which supplies the potential to the plates should be of about 80 to 100 volts, while a 4 volt accumulator is usually best for the filament.

If the plate of the last valve is connected through a small variable condenser C-5, or a very high resistance R-5, to the grid of the first valve, a further increase in the strength of the signals is noted. By suitably adjusting the resistance or condenser, the circuit can generally be made to oscillate and continuous wave signals may then be received. The resistance and condenser together with a switch S and connections are shown on the diagram by dotted lines.

The results obtained with such an amplifier are very satisfactory. The adjustments are simple, when compared to the circuits employing inter-valve transformers. With transformers the rectification of signals is chiefly left to the first valve which often has to deal with very weak signals and therefore small variations of grid potentials. In this circuit the incoming signals are first amplified.

So simple and economical an amplifier should appeal to amateurs. Its sensitiveness and peculiarity of amplifying weak signals to a far greater extent than strong ones, should be of great assistance to those who wish to receive from stations which hitherto have been unreadable owing to the great distances being spanned or because of using too small an aerial.

A High Frequency Generator for Code Practice

THIS instrument, as constructed by the writer, was made entirely from old apparatus found around the workshop. The generator will furnish enough power to operate from one to six or even more telephones over a line from room to room in the same building. It furnishes an ideal source of high frequency oscillations for fast sending. This is due to the fact that there are no vibrating parts to be stopped and started between each character, as is the case when a buzzer is used. The writer does not claim to be the originator of the principle involved but only of the details of application.

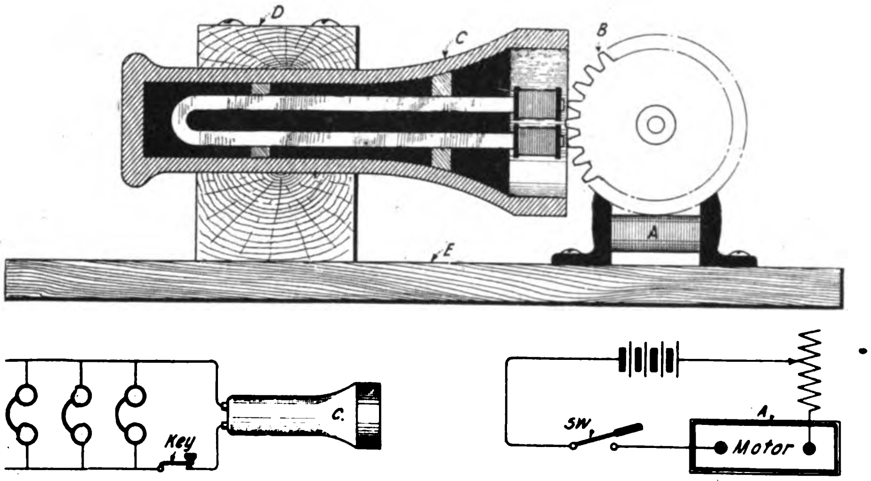


Figure 1—Showing construction and connections of the high frequency generator

There are three fundamental parts to the generator. "A" is a small Ajax motor which had been rewound with small wire (size about No. 24) to reduce its current consumption. When running it takes from three-quarters to one ampere depending on the speed. "B" is an iron gear two inches in diameter by one-quarter inch thick with twenty-five teeth. The gear used by the writer was taken from an old lathe. It was put on an arbor and turned down to the right thickness and then fastened on the motor shaft by a brass bushing, which was made long enough to allow a set screw to be inserted. "C" is an old pear shaped telephone receiver with the cap and diaphragm removed.

The motor is screwed to one end of base "E" and the telephone receiver is supported by a split block "D." The top of this block is clamped to the lower part by two screws, one in each side of the telephone receiver. A small rheostat may be mounted on the base for regulating the motor speed.

Any type of small motor may be used and a watch case telephone receiver will work as well as the pear shaped one if properly mounted. It is necessary, however, that the line through the center of the telephone receiver be at the same height as the center of the motor shaft. While twenty-five teeth gives the best results with the Ajax motor it is not necessary that the iron gear have exactly this number but it is absolutely essential that it be mounted true on the motor shaft if a clear note is to be obtained.

The diagram figure 1 shows the proper connections. It should be noted that there is no direct electrical connection between the motor and the pear shaped telephone receiver. The power developed by this instrument varies inversely as the distance of the telephone magnets from the iron gear.

E. S. Palmer—*Rhode Island.*

Suggestion for Prize Contest, May Issue Wireless Age.

We will pay the usual prizes of $10, $5 and $3, in addition to our regular space rates, to the three contributors who send us the best manuscripts on the following subject:

Which of the two following types of wireless transmitters do you consider to be the most practical for amateur use, namely: the panel type or the isolated instrument type?

Improved Cell Design for High Voltage Battery

ONE of the primary requisites of a modern radio receiving set, is the vacuum valve detector. Of the two sources of direct current necessary to operate this instrument, the high voltage battery gives the most trouble. Flash-light batteries are expensive and short-lived compared to the amount of current used. For those who are content to have test-tubes or other containers arranged in racks, filled with acid, the high voltage storage battery solves the problem, provided they have a convenient source of charging current. From my point of view, I believe that dry cells of a special design, easily constructed by the amateur and small enough to be contained in the receiving cabinet, solve the problem for portable as well as stationary sets.

I think the best shape for the cell, is that of a disc. The best method I have found for making the cells, is to use fibre of cardboard rings to separate the metal electrodes. The outside dimensions are about 1¾ by ⅜ inches. The fibre or cardboard ring has the same outside diameter as the finished cell and the cross section should be about ¼ by ¼ inches square. The rings are soaked in melted rubber compound, such as used to seal storage batteries, and then hung on a rod or nails so they may be removed easily when cold. The negative electrode is a zinc disc the size of the cell and the positive electrode may be copper or other metal depending on the active material in the cell. Carbon cannot be used in this type of cell to advantage.

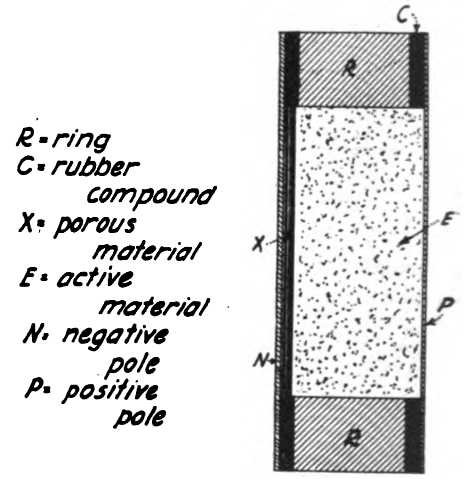


Figure 1—Detailed construction of cell for high voltage battery

The method of assembling is to place a zinc disc on one of the rings and then press it down with a hot flat-iron until the rubber compound is melted. Then a cold one is put on with pressure until the compound is cold. A tight fitting disc of blotting paper is placed next to the zinc on the inside and the electrolyte, in the form of a paste, is next applied. A layer of some depolarizing agent such as black oxide of manganese should complete the filling. Then the other electrode should be sealed in position as the first.

In presenting this suggestion to your readers, I hope some of them will be interested enough to start where I am obliged to leave off, i. e., the finding of the best material for the positive electrode and the electrolyte for the highest efficiency. These cells would have many advantages such as, their cheapness, their small size and ease of construction. Thick metal discs should be placed at each end and a little pressure maintained at their centers by set screws. These act also as binding posts.

Leo. M. Lafave—*New York.*

First Aid to the Amateur

By E. T. Jones

A Detector Stand.

THE detector in figure 1 was constructed mostly of parts of a telegraph sounder and a telegraph key. The support U for the swinging arm A which also carries the contact point originally was the support of a telegraph sounder which held the lever. The crystal holder H is made of a U shaped piece of brass and an 8/32 screw is passed through it at the top to clasp the mineral in its ends. The adjusting knob K is an 8/32 screw with a key knob for its handle. A small piece of tapped hard rubber somewhat similar to the handle of the switch handle on the key gives it a finished appearance.

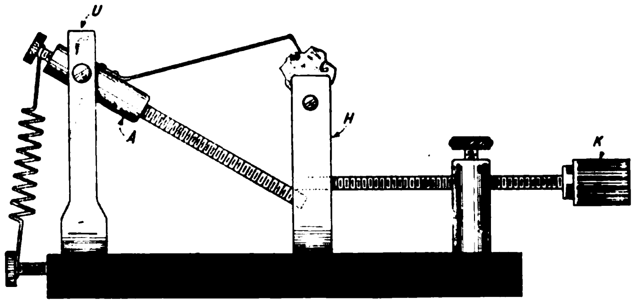
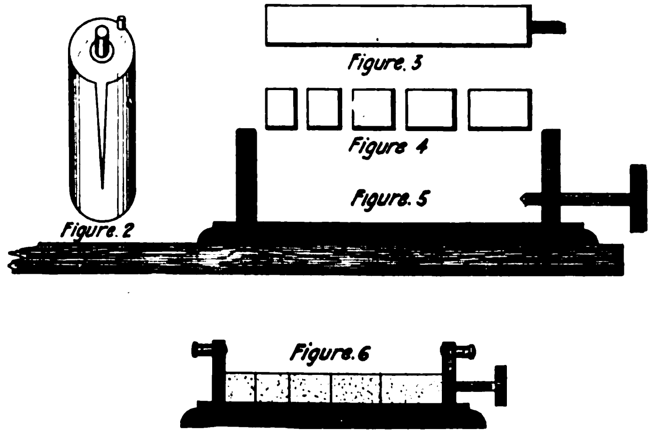


Figure 1—View showing the construction of the detector stand

The main advantages of this detector are that immediately a good adjustment is secured the point can be raised while sending and returned to the exact spot for receiving merely by turning the handle and lowering it to its original position. This is a feature that cannot be obtained from any other form of detector holder. It is optional what kind of mineral is used as the adapter is made to hold any of the well known types. I find this to be one of the best detectors I have had the pleasure to work with owing to the fact that whenever one desires to send he merely has to take the point off the mineral and when finished lower it gradually until the point comes in contact with the exact spot used before.

A Compressed Carbon Rheostat

The variable resistance element of this rheostat is the carbon electrode of an ordinary Columbia No. 6 dry cell. As shown in diagram figure 2, this may be removed by simply splitting the zinc down the edge with the sharp edge of a hatchet. Figure 3 shows the carbon when removed, and figure 4 shows the same carbon with the binding post removed and cut into small blocks of different lengths. Figure 5 shows a suitable stand for the blocks which permits a variable pressure, thereby raising and lowering the resistance at will. Figure 6 shows the completed apparatus.



Figures 2, 3, 4, 5—Detailed construction of the compressed carbon rheostat. Figure 6—The complete device

The blocks can be cut into very thin strips, that is, about ⅜" or ½" thick thereby increasing the resistance. This is a very good instrument for the laboratory and one which is easily constructed and operated.

A Cat Whisker Detector.

Figure 7 shows the drawings of a novel type of cat whisker detector. The mineral (galena or cerusite) is clamped in the stationary wood support (3) and held by clamp (2). The points as mounted on the copper wire (soldered) which in turn is made fast to the ¼" square brass rod (9). Each point as will be seen from the drawing is made longer than the preceding one, or they can all be the same length but each of different gauge spring wire making each a little more "springy" than the preceding one. The sliding arrangement (8-9 and 10) should be constructed to allow the rod to move to and fro easily on the wood support (6). The detector as a whole is very efficient and a point is readily found

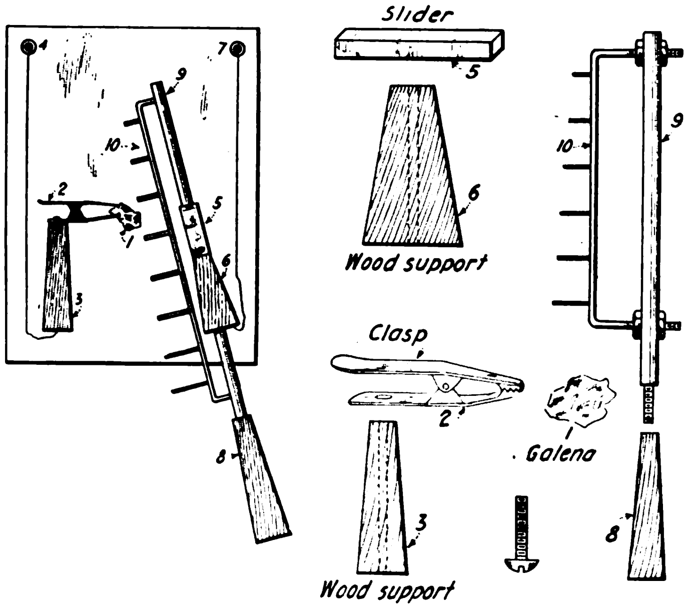


Figure 7—The cat whisker detector illustrated in detail

by sliding the arm (8-9-19) backward and forward—slowly.

A "Quick Throw" Switch.

As shown in figure 8, A and B are knife blade contacts for connection with the switch arm C. H is preferably a hard rubber or hard wood handle. A is supported by an overhanging arm D which is of hard rubber. This ought to make a good antenna change-over switch or a lightning switch. It may be used for many purposes around the amateur station.

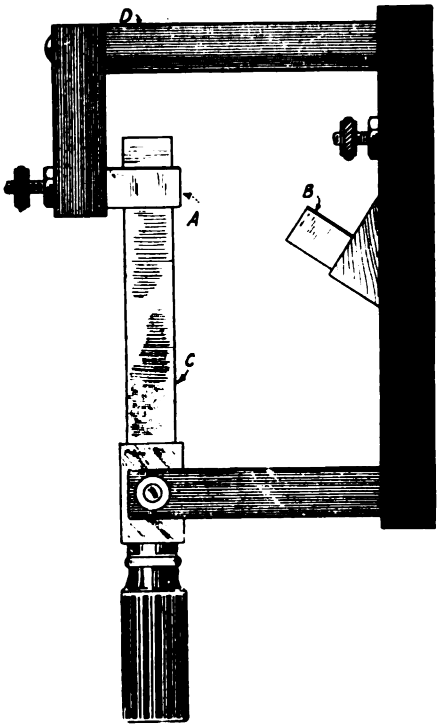


Figure 8—"Quick throw" switch

Donle's Electron Valve for Wireless Reception

COMING on the heels of a multiplicity of patents covering the design and use of vacuum valves for wireless transmission and reception, we have a newcomer for which some startling performances are claimed. Those who have been accustomed to conceive of the electron as moving with great freedom in a vacuum are now called upon to believe that the electron stream actually may pass through glass under certain conditions of temperature. H. P. Donle of Connecticut, is credited with the discovery.

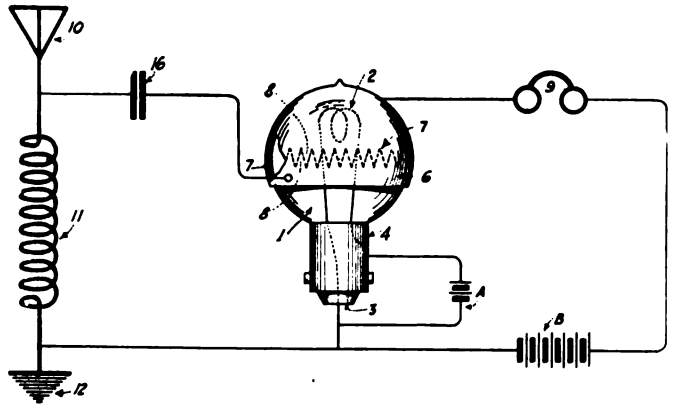


Figure 1—Donle's vacuum tube connected for radio reception

In one type of his valve shown in figure 1 the elements corresponding to the grid and plate of the usual tube are placed on the outside of the glass container. The external metallic covering 6 called the "deflector" is insulated from another metallic covering 5 called the "target." These elements are in jagged conformation which the inventor remarks to be essential to successful operation. The target and the deflector may be of silver or copper.

In his own language: "The two external conducting elements are shown as having their adjoining edges relatively closely approached but as having a clear insulating space 7 therebetween. The adjoining edges of the two elements furthermore, are indicated at 8 as of serrated or jagged outline, thus providing a zigzag intervening space between the two members. This in effect increases the areas of the two elements which are opposed to each other.

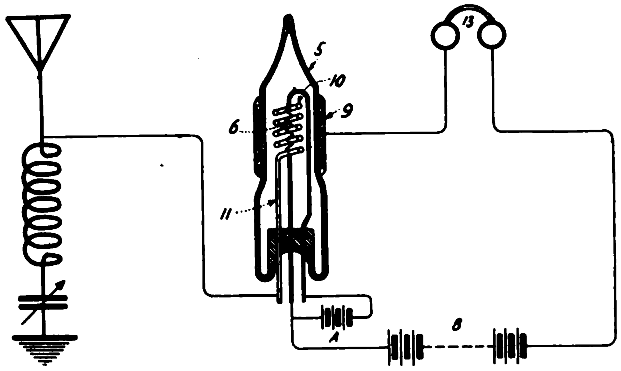


Figure 2—Modified form of tube in a modified circuit

"It is desirable that as many as possible of the electrons which control flow from the filament to the target shall be influenced by the deflector. In order that the deflector influence these electrons, its electrical field should be as close as possible to the target. The portion of the target not affected by the electrical field from the deflector will receive an uninterrupted flow of the electrons from the filament. As an amplifier, the action depends upon the volume of electron control. The deflector should therefore control as great a percentage of the electron flow as possible. This in effect is what is accomplished by the intermeshing or 'overshadowing' of the target by the deflector."

According to the inventor, when the temperature of the glass is raised to 100° C. or more, it becomes conductive to the electron stream and some current flows from the battery B through the glass and across the intervening space between the plate and filament. The circuit may be traced from one terminal of the B battery through the telephone 9 to the target 5. The other terminal of the B battery is connected to one side of the filament. The deflector 6 is connected to a terminal of the secondary circuit through the condenser 16. Direct coupling is shown at 11.

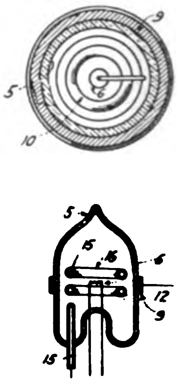


Fig. 3 (top)—Cross section
Fig. 4 (bottom)—Vertical section

The inventor declares that the electrons flow through the warm glass or other normally non-conducting wall of the globe and not simply through the evacuated space as in tubes heretofore. He states that the efficiency of the tube is not dependent solely upon the maintenance of the vacuum. Furthermore, he believes that the electron discharge at the inside of the bulb may be considered, because of its unilateral conductivity, a polarizing conductor or polarizing medium. The electrode on the outside of the bulb is of a material that does not polarize in contact with the glass and he therefore terms it a nonpolarizing layer or conductor. He believes that the deflector, connected to a source of radio frequency oscillations, varies the electron current in the tube much in the same way as in the ordinary three element tube with all electrodes inside the bulb.

A tube of modified construction and a modified circuit are shown in figures 2, 3 and 4. Figure 2 shows the tube with the filament 6 inside the grid element 10, the container being surrounded by the metallic conductor 9 which forms the anode for the tele-

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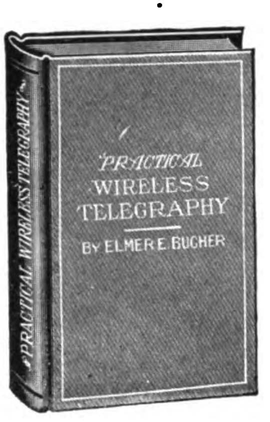

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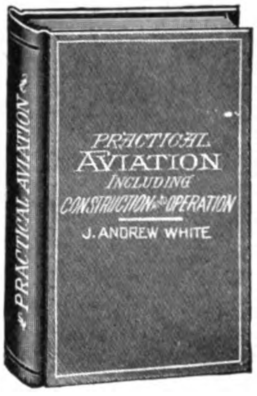

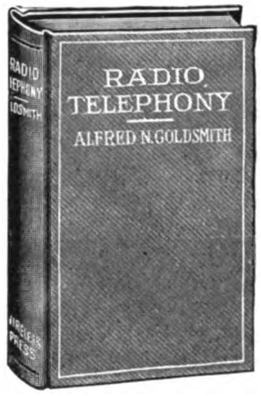

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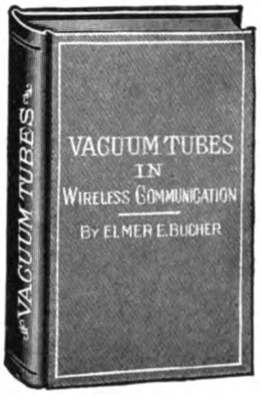

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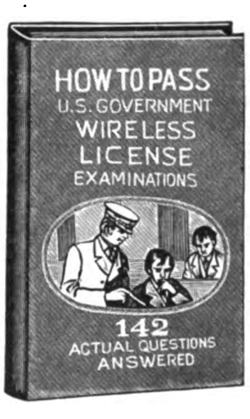

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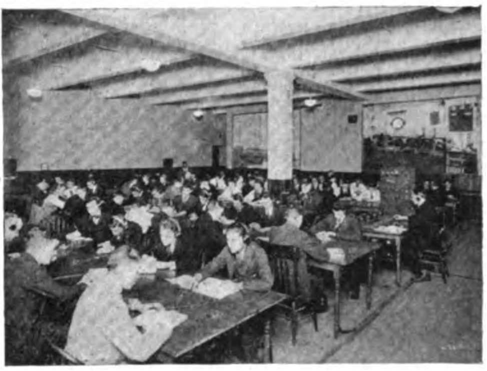

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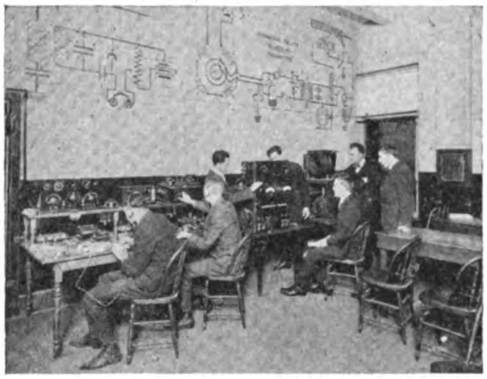

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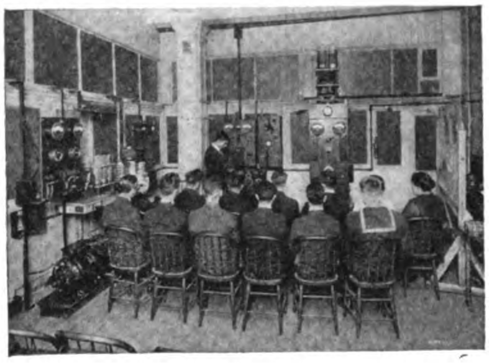

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phone circuit. The grid element 10 is connected to one terminal of the antenna circuit through the wire 14. This constitutes an open oscillation circuit which has been covered by patent specifications of another inventor. Figure 3 is a cross sectional view of the tube on the plane 2-2 in figure 2. Figure 4 is a vertical sectional view of a modified form of construction.

It is to be noted in circuit of figure 2 that the plate current furnished by the B battery is assumed to flow from the external element 9 through the glass container to the filament 6.

The operation of the tubes and the circuits in figures 2, 3 and 4 is described by the inventor as follows: "The filament when energized by the battery A heats up the globe which, as before stated, is usually made of glass or other material normally non-conductive at room temperature but which when heated to a higher temperature of say, 100° C. or over, becomes conductive to a certain degree, whereupon current from battery B passes from the anode through the heated glass to the layer of electrons on the inner wall of the globe, said current being conducted between this wall and the filament by the electron stream. If a charge is now placed upon the controlling member, as by means of radio oscillations, for instance, the flow of current through the glass is decreased by the decreasing in area of the electrons laying upon the inner wall of the globe, the controlling member apparently acting in this case to absorb unto itself a certain number of these electrons."

The operation of the tube in figure 2 is in general similar to that first described, the controlling member being connected to one terminal of the oscillation circuit. Quoting the inventor:

"The polarizing layer of electrons or ions in contact with the inner wall of the globe, it will be seen forms in effect a polarizing conductor which in combination with the non-polarizing conductor in contact with the outer wall of the globe makes of the device a rectifier which may be used as such. The device may also be used as an amplifier in which event the connections will be such that the area of the polarizing conductor will be varied according to the energy to be amplified."

Regarding the special construction in figure 3, the inventor states: "The construction illustrated in figure 3 differs from the first form described, particularly in that both the anode and the controlling member are separated from the filament or electron source by a wall of glass. In this case the anode is located on the outside of the globe 5, as in the first instance but the controlling member is in the form of a metallic coating 15 of silver, or the like, lining the inner wall of a sealed glass tube 16 located within the globe and surrounding the filament."

The Effect of a Shunt Condenser in Tuning the Primary Circuit of a Receiving Set

By Ralph R. Batcher

EDITOR'S NOTE.—A condenser shunted across the primary of a receiving tuner does not always give the desired results. Just what may be expected in practical operation, the author explains by a simple mathematical analysis. Careful study of this article may help the experimenter to understand some of the apparent "freaks" met with in "parallel tuning."—Technical Editor.

THE effect upon the wave length of the antenna circuit when a condenser is placed in series with the localized inductance, is well known. This method is often used to cut down the wave length of the circuit. However, the practice of placing the condenser in parallel with this inductance, does not always lead to the results that were expected.

The circuit shown in figure 1 typifies the shunt connection. If we allow the letter R to stand for the ratio between the wave length resulting from particular adjustments of L_1 and C with respect to fundamental wave lengths of the antenna, i.e.,

(1) $R = \lambda_1 \div \lambda_0$, it will be shown in the latter paragraph of this article that the following relation is obtained:

(2)
$$\frac{C}{C_0} = \frac{R^2 L_0}{L_1} + \frac{R^2}{1 - R^2}$$

It would be advantageous to solve the above equation for R but the solution of a fourth degree equation is in this case more complicated than in the above form. It is also impossible to plot the above equation as it stands owing to the fact that it contains five variables. However, L_0 and C_0 are constants for any one station so that absolute values can be ascribed to them and an illustrative solution worked out by curves.

Suppose that $L_0 = 50{,}000$ c.m. and $C_0 = .00025$ mf. (which are the approximate values of an antenna 60 feet high and 60 feet long). The equation now contains but three variables and can be more readily plotted. Curves showing the value of R with C ranging in value from 0 to .005 mf. for several values of L_1 are plotted in figure 2.

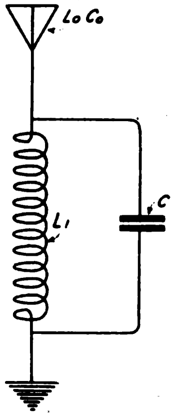

Figure 1

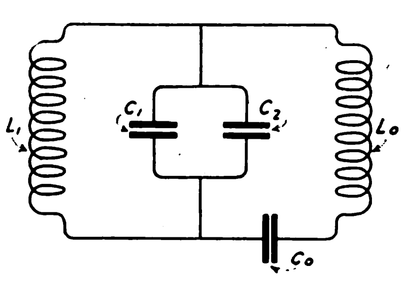

Figure 3

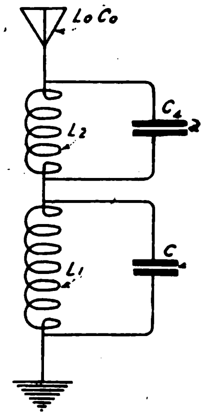

Figure 4

Symbolic diagrams of "parallel tuning"

It will be seen that this circuit can be used for lowering the wave length as well as raising it. This principle has been used for many years by certain commercial companies to lower the wave length of an antenna to a value below the natural wave length, but amateur operators have rarely made use of it knowingly.

Similar curves may readily be drawn for any antenna if its inductance and capacity are known. In this article the effective values of the inductance and capacity only are used. There has been no attempt to consider the distributed nature of L_0 and C_0, as its introduction would tend to complicate the formula and to obscure the results that were to be disclosed in this article. Other formulæ* have been recently published that can be applied to the distributed values of L_0 and C_0 to obtain their effective values. These latter values should be used in formula 2.

In plotting these curves it will be

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* See Bureau of Standards Bulletin No. 74, pages 71-86.

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found that the computations are simpler if values are assumed for R and for L_0 and the corresponding value of C obtained by substituting these values in the formula.

It will be seen by analyzing the sample curves that there are certain wave lengths, around the fundamental wave length of the antenna that cannot be received with this circuit, except with very small values of L_1 and C. In other words the circuit L_1C acts as a high impedance for these wave lengths. It will also be noticed that there are certain combinations of L_1 and C, that make the circuit responsive to slight changes of capacity, and that at other places a large variation of the condenser C is needed to produce a given change of wave length. Doubtless every amateur has noticed this condition in practice but was unable to account for it. The circuit will always respond to two wave lengths, one above the other below the fundamental wave length of the antenna.

Applying this method to a transmitting circuit to enable the operator to use a rather large antenna for 200 meter waves, it will be seen that some sort of a filter circuit must be added in series with antenna, to shut out the unwanted frequency. This additional circuit added to the antenna circuit would probably decrease the efficiency of the apparatus, but it remains to be tried out in practice to determine whether it is better than a plain series condenser to accomplish the same result. Figure 4 shows the apparatus needed to cut the natural wave length down in this manner. L_2 and C_4 must be of such a value that they correspond to the undesired wave length produced by the condenser C.

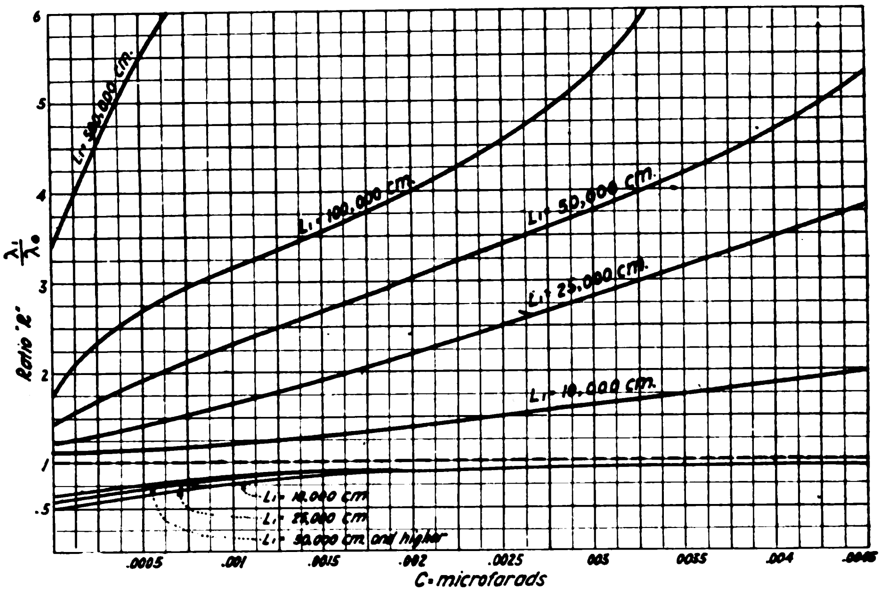

Figure 2—Graphic curves showing ratio values in shunt condenser connection

The derivation of the formula is as follows:

The equivalent circuit corresponding to figure 1 is shown in figure 3.

$$\text{Let } \lambda_0 = 59.6 \sqrt{L_0C_0}$$
$$\text{and } \lambda_1 = 59.6 \sqrt{L_1C_1} \qquad [2]$$

An emf. of frequency n will effectively "split up" the condenser C into two capacities C_1 and C_2 so that both circuits L_1C_1 and $L_0C_0C_2$ will if possible be in resonance with the frequency n. Then

$$L_1C_1 = \frac{L_0C_0C_2}{C_0 + C_2} \qquad [3]$$

squaring eq [2]

$$\lambda^2_1 = \frac{L_0C_0C_2(K)}{C_0 + C_2} \qquad [4]$$

$$\text{and } \lambda^2_0 = L_0C_0(K)$$

solving [4] for $C_2 \div C_0$

$$\frac{C_2}{C_0} = \frac{\lambda^2_1}{\lambda^2_0 - \lambda^2_1}, \qquad [5]$$

from eq. [2] and [3]

$$\frac{C_1}{C_0} = \frac{\lambda^2_1 \times L_0}{\lambda^2_0 \times L_1}, \qquad [6]$$

adding [5] and [6]

$$\text{Let } C = C_2 + C_1 \text{, then}$$

$$\frac{C}{C_0} = \frac{\lambda^2_1 L_0}{\lambda^2_0 L_1} + \frac{\lambda^2_1}{\lambda^2_0 - \lambda^2_1},$$

substituting $\lambda_1 = R\lambda_0$,

$$\frac{C}{C_0} = \frac{R^2L_0}{L_1} + \frac{R^2}{1 - R^2}$$

This last formula is the one given at the first of the article.

Contest Winners for the April Issue

In response to the call in the February issue for manuscripts concerning the ideal amateur set, prizes have been awarded to the writers of the following articles. The subject upon which the contest was based was: What, in your opinion, is the most efficient receiving set for amateur wave lengths, and what should be the dimensions of the antenna and the tuning coils for best results?

First Prize—A Short-Wave Regenerative Receiver

THE receiving tuner herein described is designed for use on an average amateur aerial having a natural wave length of about 175 meters. An inverted L type aerial, 80 feet long and 60 feet high, answers these requirements, although the length and height may be varied to fit the location. A natural period greater than 175 meters is not recommended if the station is to operate on 200 meters, as an aerial of such dimensions will not permit sufficient inductance in the primary of the receiving tuner, nor in the secondary of the transmitting oscillation transformer, for efficient transformation.

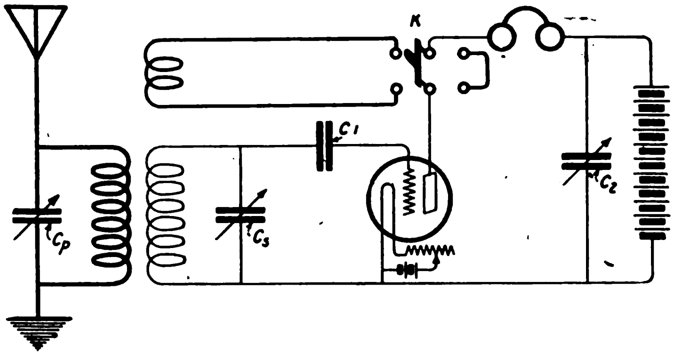

Figure 1—First prize article

In choosing a type of receiver for amateur purposes, and for construction by amateurs, three fundamental points should be considered: 1st, efficiency; 2nd, simplicity of construction; and, 3rd, ease of operation. That these points have been carefully kept in mind in the tuner described, the following will bear out.

With respect to efficiency, it should be noted that this type of circuit has been adopted by the Navy Department, the U. S. Signal Corps, and by many foreign governments. The size of wire for the coils herein specified will give maximum conductance, which IS IMPORTANT, contrary to the popular belief that, because the vacuum tube is a potentially-operated device, its efficiency is not lowered by using fine wire. The absence of variometers eliminates another source of energy loss, and the tuning of the secondary by a condenser instead of taps, makes a further improvement.

The simplicity of construction will be apparent after noting the details given. There is an efficient circuit employing variometers, but the construction of a variometer is much more difficult than the simple coils required in this tuner.

This receiver consists of three coils, a primary, a secondary, and a tickler coil. The primary and secondary are each shunted by a variable condenser of 0.0005 mfd. capacity, and a variable condenser of 0.001 mfd. capacity is shunted across the high potential battery.

The primary coil is a tube three inches in diameter, wound for a distance of one inch with 30 turns of No. 22 D.S.C. magnet wire, and tapped to two 5-point switches for single turn variation. This coil has a total inductance of 0.1 millihenries, and if used on the aerial described above, with the shunt condenser, will respond to wave lengths ranging from 200 to 600 meters.

The secondary coil is a tube 2½ inches in diameter, wound with 50 turns of No. 24 D.S.C. magnet wire. No taps are taken from the secondary, the variation of wave length being obtained by the variable condenser. The secondary has an inductance of 0.14 millihenries, and will respond to the same range of wave lengths as the primary. A maximum separation of 6 inches between the primary and secondary coils should be provided, but the constructional details can be varied as individual requirements may dictate.

The tickler coil is wound on a wooden ring, the center of which is turned out large enough to permit sliding the ring over the secondary. A groove is cut out on the edge of this ring, the inside diameter of which is 3 inches, the width ⅜ inch. In this groove are wound 12 turns of No. 18 annunciator wire, in 3 layers of 4 turns each. A D.P.D.T. switch is provided

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for throwing the tickler coil out of circuit when a plain valve connection is desired, and the coil is so designed that its insertion will not detune the secondary circuit.

When operating this receiver, the desired signal is tuned in with the switch K to the right. When this is accomplished, the tickler coil is thrown into the circuit and moved over the secondary until regeneration occurs. Condenser C2 is then adjusted, and the coupling gradually loosened, so that freedom from interference will be obtained. It is possible to receive strong signals with a very loose coupling, as the amplification obtained (3 to 6 times) will compensate for the loss of energy resulting therefrom.

By the use of suitable loading coils in the primary and secondary circuits, this tuner will respond to waves as long as 2,000 meters, but it is advisable to remove these coils completely from the circuits when short waves are being received.

In conclusion, I would say, the construction of this tuner will prove a revelation to many amateurs who have been content with the simple vacuum tube connections heretofore employed, and will certainly repay anyone for the time and materials expended.

Arno A. Kluge—*California.*

Second Prize—A Receiving Set for Amateur Wave Lengths

THE amateur is, of course, primarily concerned with the reception of signals from amateur transmitting sets which usually operate at the wave length of 200 meters. To do this most efficiently he ought to design a set especially for short waves. Such a set was constructed by the writer in the Physics Department of the State College for Teachers at Albany, N. Y. and exceptional results were obtained with it. Amateur stations in Ohio, New Jersey and even Nebraska were heard far above readable loudness. The wiring diagram appears in figure 1.

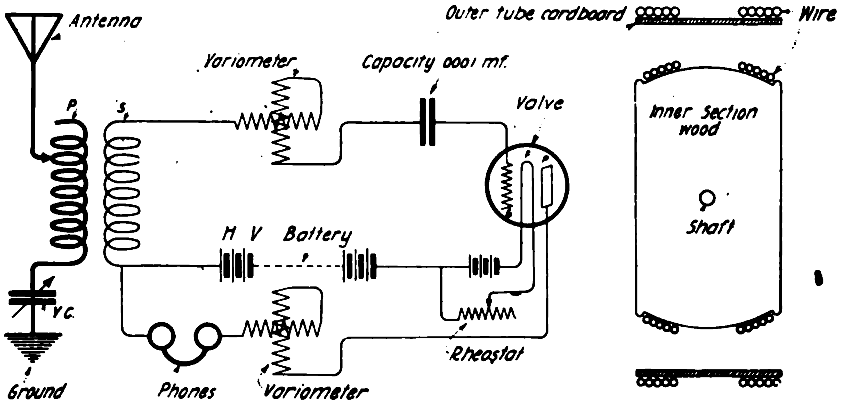

Figure 1—Second prize article

A regenerative vacuum tube receiver is used. With such a set it is advisable to use small capacities and provide a means for carefully regulating the inductance continuously from a minimum to a maximum. Such variation may be effected by placing two coils, having equivalent values of inductance, concentrically with provision for rotating the inner one to vary their self-inductance.

The mutual induction between two wires varies inversely as the distance between them. It is, therefore, well to construct the inner coil of the variometer so that its winding will be as close as possible to that of the outer coil. In order to do this the inner coil is wound on part of a spherical surface, that is, a section of a ball, made of wood. This section is 3 inches in diameter and 1½ inches wide. It is made to rotate by means of a brass shaft, within a carboard tube 1½ inches wide of the correct diameter to allow clearance. The tube and the inner core are both wound nearly full with equal quantities of No. 28 copper wire in one layer. The coils are then arranged in boxes and provided with a handle carrying a pointer which travels over a scale of 180 degrees.

Two of these variometers are connected in the circuit of a specially constructed coupler. The primary of the coupler contains some 20 turns of No. 28 wire on a cardboard tube about 6 inches in diameter. The secondary coil has 15 turns of wire on a tube 5½ inches in diameter. Provision is made to allow very loose coupling between the primary and secondary. A complete circuit diagram is shown in figure 1.

It would be of further advantage to wind the outer coil on a curved surface to bring the two windings in close proximity. This, however, is difficult without proper tools. The side drawing of figure 1 gives the constructional details of the variometer.

The antenna should be as high as possible. A two wire aerial 150 to 200 feet in length with the wires spaced 4 to 6 feet will do. The variable condenser in series with the primary circuit gives very close tuning and is essential for very short waves. An additional variometer might be connected in the antenna circuit.

Although amplifiers are in use at the college laboratory, the records mentioned above were made without an amplifying device of any sort.

E. L. LONG—*New York.*

Third Prize — Amateur Radio Receiving Station

THE set I am about to describe is very efficient for wave lengths between 200 and 3,000 meters. It is easily constructed, low in cost and employs but one vacuum tube. I use two couplers and two aerials. One aerial and tuner are built specifically for 200 meters, and the second combination for wave lengths up to 3,000 meters.

The large coupler may be any good make of transformer the operator has on hand, but I recommend that the 200 meter be specially constructed. By means of a change-over switch either coupler and aerial may be employed as desired. I consider the "T" type antenna to be the most efficient for short wave work, but for longer wave lengths I would advise a separate antenna of the "L" type about 175 feet long and as high as possible above the earth. The higher it can be elevated the longer the range. The "T" type should be 100 feet long and 60 feet high of 2 wires of stranded phosphor bronze spaced about 8 feet apart, the vertical section being separated about 15 feet above the earth by an 8 foot spreader. For the "L" type only one wire is necessary, 175 feet long and 60 to 100 feet high.

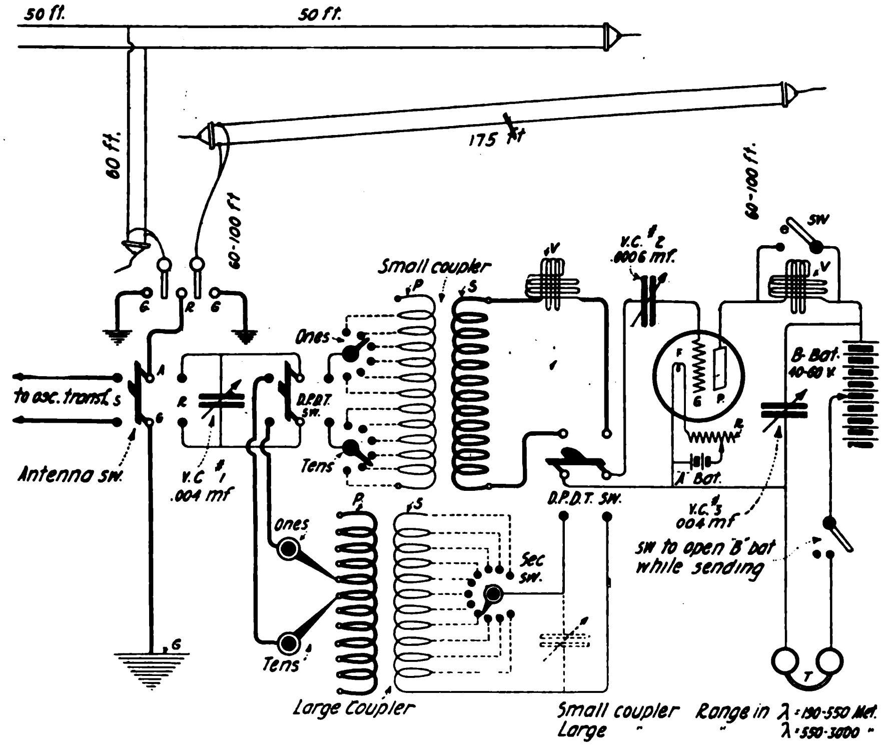

Figure 1—Third prize article

The primary coil for the short wave coupled in figures 1 and 2 should be 3 inches long, 3 inches in diameter, wound with No. 24 S.S.C. wire tapped so as to allow a variation of one turn at a time. The secondary should be 2½ inches long and 2½ inches in diameter wound for 1¾ inches with No. 28 S.S.C. wire. It is not necessary to take any taps off of the secondary. A small variometer is used in the secondary circuit to allow very fine tuning.

A full description of a variometer which is very efficient for this purpose may be found in the book "How to Conduct a Radio Club."

A small variometer of a simple design may be constructed that will answer this purpose very well. The outer coil should be 3½ inches in diameter, 1½ inches wide, wound with 25 turns of No. 28 S.S.C. wire. The inner coil should be 3 inches in diameter wound with No. 28 S.S.C. wire. Care should be taken that the inner coil has the same amount of wire as the outer coil. Cardboard tubes may be used and the wire should be well shellaced. It may be mounted on a base and placed on the operating table, or if so desired it can be mounted on the back of the panel board, with the rod that is used for rotating the inner coil extending

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Local and County Representatives Wanted to present this course to wireless amateurs, radio operators and experimenters.

through the panel. With the pointer and scale on the front of the panel, it presents a very neat appearance.

The large coupler has a primary 5 inches in diameter and 6 inches long wound with No. 24 S.S.C. wire tapped so as to allow a variation by one turn at a time. The secondary should be 4 inches in diameter, 5 inches long wound with No. 28 S.S.C. wire, tapped every ⅜ of an inch.

Variable condenser No. 1 should have a capacity of about .004 mfd. Variable condenser No. 2 has about .0006 mfd. capacity. The variable condenser shunted across the telephones has a capacity of .004 mfd. It can be replaced by a fixed condenser of similar capacity but it reduces the efficiency especially in the short wave set. Variable condenser No. 3 can also be replaced by a small fixed condenser made of a piece of mica 2 x 4 inches covered on each side with tin foil; but for the best results I believe a small variable should be used.

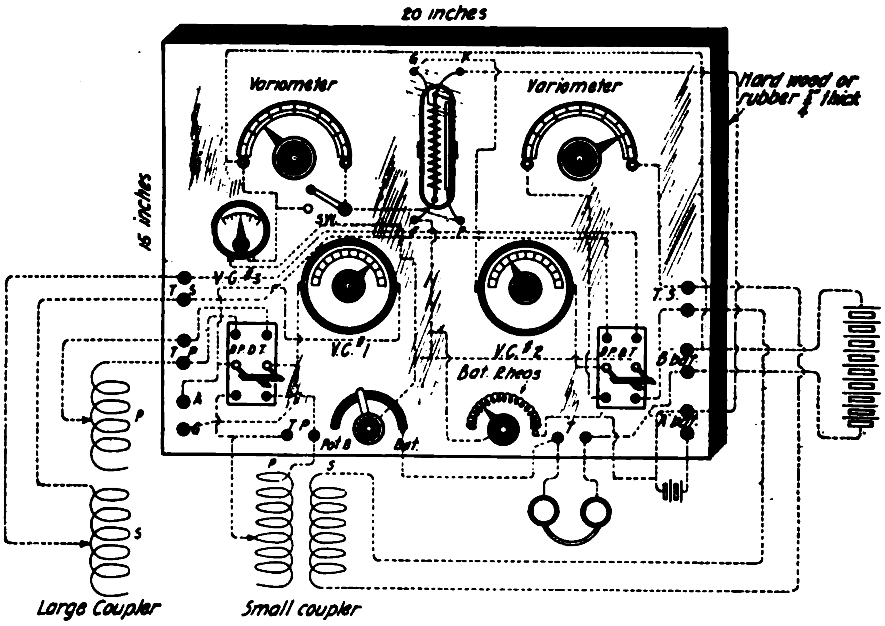

Figure 2—Third prize article

The variometer in the plate circuit should be the same in design and size as the one described above, and if properly constructed will give considerable increase in signals on the low waves. It should be shunted by a small switch so that it may be cut out when using the larger transformer.

By means of the two double pole double throw switches shown in the diagram, either of the couplers may be connected to the valve detector. This does away with the dead end effects that are particularly noticeable on the two hundred meter wave lengths. This set may not look so well as the cabinet type of short wave regenerative receivers on the market for amateur use, but if properly constructed it will give equal results. The appearance of this set can be increased considerably by mounting it on a panel except the tuning couplers which should be mounted on the operating table. The telephones can be any standard make such as the Brandes or Murdock 2,000 ohm type which I find to give equal if not better results than the telephones ordinarily employed. A fundamental wiring diagram appears in figure 1 and the assembled apparatus with all connections in figure 2.

W. S. Taylor—*New York.*

A Method for Reviving an Audion "B" Battery

I THOUGHT perhaps it might be of interest to amateurs to know how to revive their old "B" batteries used with three element vacuum tubes and save money. I carefully stripped the old cells of their zincs, leaving the wax on top of each carbon and scraped the decomposed zinc from the bag around the carbon. I made new zinc cups, lined them with paper and soaked them in a solution of zinc chloride and saturated ammonium chloride. I also soaked the carbon sacks in the same solution. The proportion of the two chemicals is not very important, one part ZN CL to two or three NH_4CL being used. The cells worked over in that way gave 1.4 volts. The zincs were formed around a cylinder of the right diameter and soldered. It is a rather big job, but if ten-cent flashlight batteries are not to be had it saves money.

Jacob Jordan—*Indiana.*

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Pre-War Amateur Radio Work

MANY of the radio amateurs throughout the United States will be interested in the pre-war distance records made by Station 6EA, at Los Angeles, California, some of which have never been published.

Radio amateurs on the Pacific Coast have done some very excellent long distance work both in regard to transmission and reception. Our amateur radio station, for one, obtained good results, especially between the hours of ten-thirty at night, and two and after, in the morning. Using a homemade regenerative receiver, the writer picked up 9ZN of Chicago, (1730 miles) on a wave of 425 meters, calling 9ZF of Denver. This occurred during March, 1917, on a clear evening after midnight. In February, 1917, we heard 7ZC of Lewiston, Montana, (1,005 miles), also on a 425 meter wave. He was working with 7ZN at Vancouver, Washington. Another night in February we picked up two stations on 425 meters. One was 9XN at Grand Forks, North Dakota, who was calling 9XV, 5BV and 8YI, between the hours of ten and midnight. The other one was 5ZC at Dallas, Texas, who was heard working with 5ED after midnight. These distances are, respectively, 1,445 and 1,240 miles. The above mentioned distances are the maximum we have been able to cover.

We have had excellent results in transmitting over long distances. Our transmitter is entirely homemade and of half-kilowatt capacity. The aerial is of the inverted "L" type, fifty feet high and forty-five feet long, giving a wave length of about 195 meters.

We received a letter from the operator at the Marconi station KDU, at Juneau, Alaska, stating he had heard our signals quite distinctly while we were working with 7ZN, on March 1, 1917, at eleven-fifty p. m., Sitka time (12.50 A. M. Pacific Coast time). The distance to Juneau, Alaska, from Los Angeles as computed by spherical trigonometry, is 1,840 miles, which is our record transmission. The operator at KDU was using the Marconi type 101 tuner, crystal detector, and Baldwin Mica diaphragm receivers.

The steamer D. G. Scofield (WRD) heard our station 1,289 miles west of San Francisco, which is approximately 1,500 miles from Los Angeles. This same ship picked up our station when 20 miles north of Seattle. Station 9ADL of Milwaukee, Wisconsin, heard our signals, the distance being 1,730 miles.

The above is a fair illustration of the possibilities in amateur long distance communication previous to the war. By utilizing some of the discoveries made during the war, these records will undoubtedly be excelled.

HOWARD C. SEEFRED—*California.*

Undamped Stuff

I tired of interference, so I though it would be fine
To buy a tube and build myself a feed-back heterodyne,
To hear the latest line of dope, swift-wing'd by night and day,
From Eiffel Tower or Babylon, Iceland and far Cathay.

(*That was the prolog*)

I scraped up microfarads, enough to choke a horse;
A flock of milihenries too, to balance up, of course;
Then I beat 'em all together till the racket made me deaf,
And multiplied each screw and bolt by L C 2 Pi F,
I made a characteristic curve, I liked the way it bent,
I smeared the proper volts and juice upon the filament,
And hooked up just enough dry cells for pressure on the plate.
Nothing went amiss, I thought—but it wouldn't oscillate!
I tied a new condenser with a leak up to the grid;
Then I jerked it out again; but no matter what I did,
My efforts were in vain; I tried most everything
But no canary bird inside woke up to start to sing.

Avaunt, O, feed-back heterodyne! and straightway let's prepare
Another way to hear the lay of sigs in ether'd air.
From dark to dawn, to list, adorn'd, in chaste and simple nighties,
While the stuff comes in on bent hairpin and good ol' iron-pyrites.

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The Vacuum Tube Transmitter for the Amateur

AMONG the manuscripts published in the January issue of THE WIRELESS AGE on interference, the one by A. J. Holborn is of real value. The vacuum tube transmitting set is practical. It is easy to operate when the proper tubes can be had. Of course, any undamped wave sender is more efficient than spark sets.

Any oscillating audion set such as used for receiving from arc senders may be used for transmitting. I wonder how many amateurs ever stopped to think that their heterodyne receiving sets are sending out feeble undamped waves.

I have repeatedly used an ordinary receiving set of the above type to transmit over a distance of almost one-half mile. The source of energy was the small B battery in the plate circuit. With a standard set using 50 watts I have carried on excellent communication over a distance of 18 miles. I give these examples to show that my "dope" is not theoretical but is based upon actual experiments.

Among other tests, three sets of equal power were operated at equal distance from a receiving station at only 10 meters difference in wave length. The receiving operator was able to read any of the three at will without undue interference from the others.

By using the hook-up formerly employed in the receiving set and substituting a larger tube and a higher plate voltage, considerable power may be radiated. In case one tube is not sufficient, they may be operated in parallel.

Two pieces of apparatus called for which may be difficult to obtain are a proper tube and a source of high voltage for the plate circuit. It is customary to use a motor generator set to change any convenient source of current such as 110 volts AC into about 300 to 500 volts DC. A high voltage battery of reasonable cost may be on the market at a later date.

GEO. E. BAKER—*Texas.*

Queries Answered

Answers will be given in this department to questions of subscribers, covering the full range of wireless subjects, but only those which relate to the technical phases of the art and which are of general interest to readers will be published here. The subscriber's name and address must be given in all letters and only one side of the paper written on; where diagrams are necessary they must be on a separate sheet and drawn with India ink. Not more than five questions of one reader can be answered in the same issue. To receive attention these rules must be rigidly observed.

Positively no Questions Answered by Mail.

H. P. M., Royse City, Texas:

The crystaloi detector will not respond to undamped oscillations, therefore your first query does not require further comment.

In reply to query No. 2, the dimensions of an aerial for receiving foreign stations abroad are immaterial, provided you possess sensitive receiving apparatus. A cascade radio frequency amplifier will permit reception of signals over enormous distances with small antennae.

* * *

A. N. W., Bolivar, N. Y.:

Ques. (1)—I have a telephone generator giving about 115 volts and 2 to 3 amperes. When run at 2,000 R.P.M., it should give over 300 watts, 60 cycle A. C. Barring difficulties, such as heating, could this generator be used to excite a ¼ kw. closed core transformer for wireless transmission or experiment?

Ans. (1)—If the output of this generator is as you state, and it does not overheat on full load, we see no reason why it could not be employed in the manner you state.

Ques. (2)—I have an 8 volt, 10 ampere dynamo which I desire to employ to charge a storage battery to be placed 800 or 900 feet from the source. What size wire would you suggest as being desirable to carry the necessary charging current with a minimum of line loss?

Ans. (2)—A No. 6 or No. 8 wire would have sufficient current carrying capacity to meet this requirement.

* * *

W. P. B., Freedom Station, Ohio:

In reply to your first query, we are unable to give you data regarding an earth transmitting system, because you have not stated the type of apparatus you wish to use. If you will go to a local Public Library and obtain a copy of Fahie's "History of Telegraphy," you will find complete descriptions of various types of induction telegraph systems.

In regard to the matter of receiving aerials: the dimensions make little difference if you use a vacuum tube amplifier as a detector. For the reception of amateur wave lengths, the antenna should not be more than 120 feet in length. Two wires will do as well as four wires.

We have no data on the Arlington and Key West press schedules, but we presume that the old schedule will be adhered to in the future.

Replying to your fourth query: The radio stations of the United States employ both damped and undamped wave transmitters. Ships generally use spark transmitters although the larger battleships have installed high power arc transmitters for long distance communication.

The book "How to Conduct a Radio Club," will give you complete dimensions of a receiving tuner suitable for reception of the time signals. The text-book "Practical Wireless Telegraphy" contains a description, with dimensions, of a receiving tuner for wave lengths up to 12,000 meters.

* * *

M. L., Champaign, Ill.:

Your questions regarding a specific type of vacuum tube are too general. In fact the data you have supplied is insufficient to give you definite information regarding the circuit for this particular tube. Various connections are used in vacuum tube transmitters and some of them cannot be published until the signing of the armistice. The text-book "Vacuum Tubes in Wireless Communication" gives numerous diagrams covering the vacuum tube situation in general.

Regarding the 500 watt generator for the vacuum tube: It is suggested that you communicate with the Crocker-Wheeler Co. of New York, for further details.

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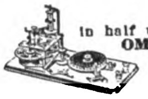

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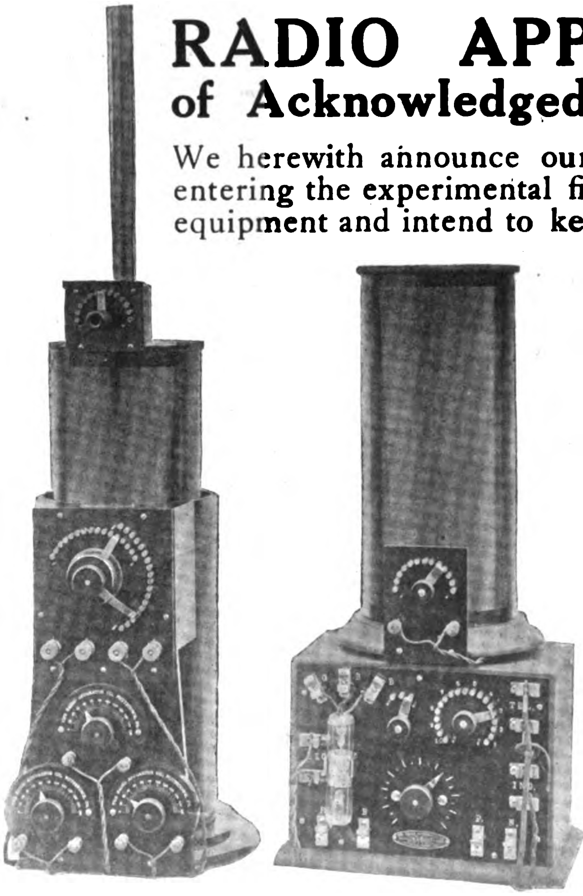

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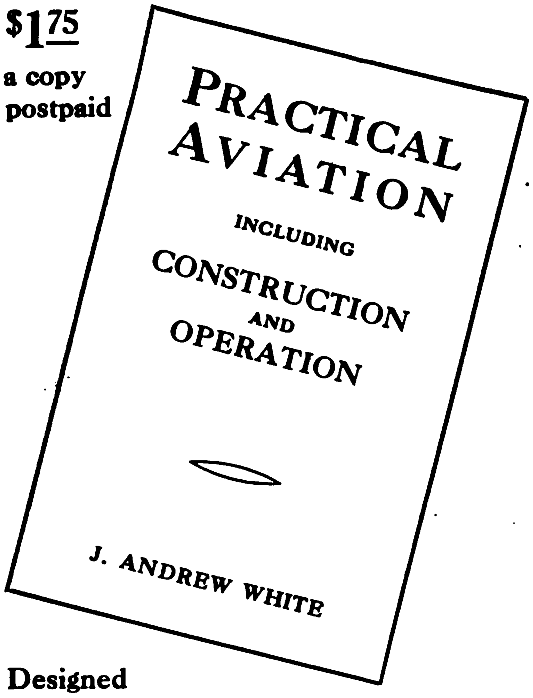

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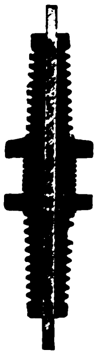
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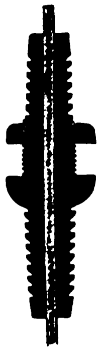
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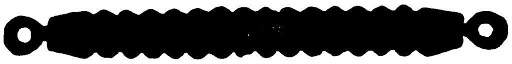
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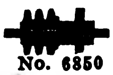
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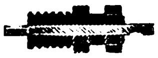
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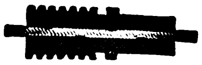
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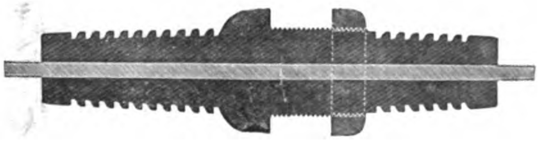
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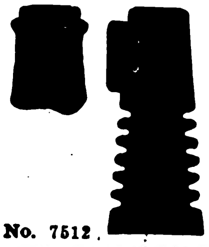
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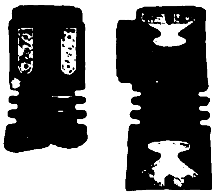
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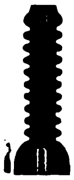
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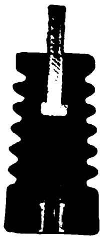
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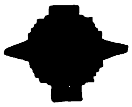
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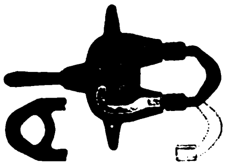
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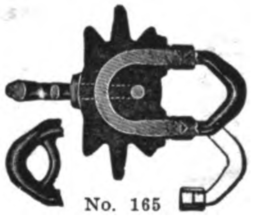
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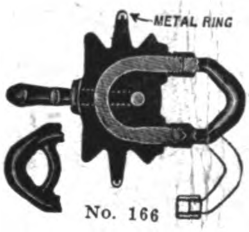

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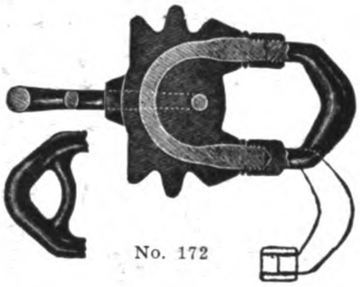
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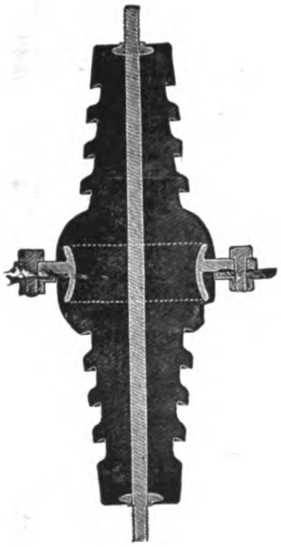
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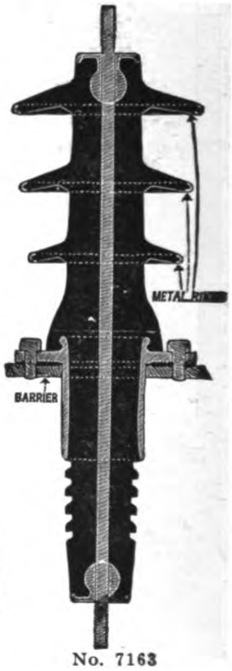

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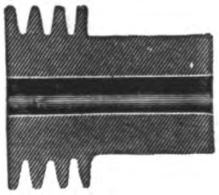
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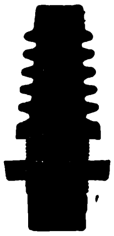
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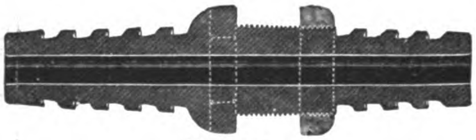
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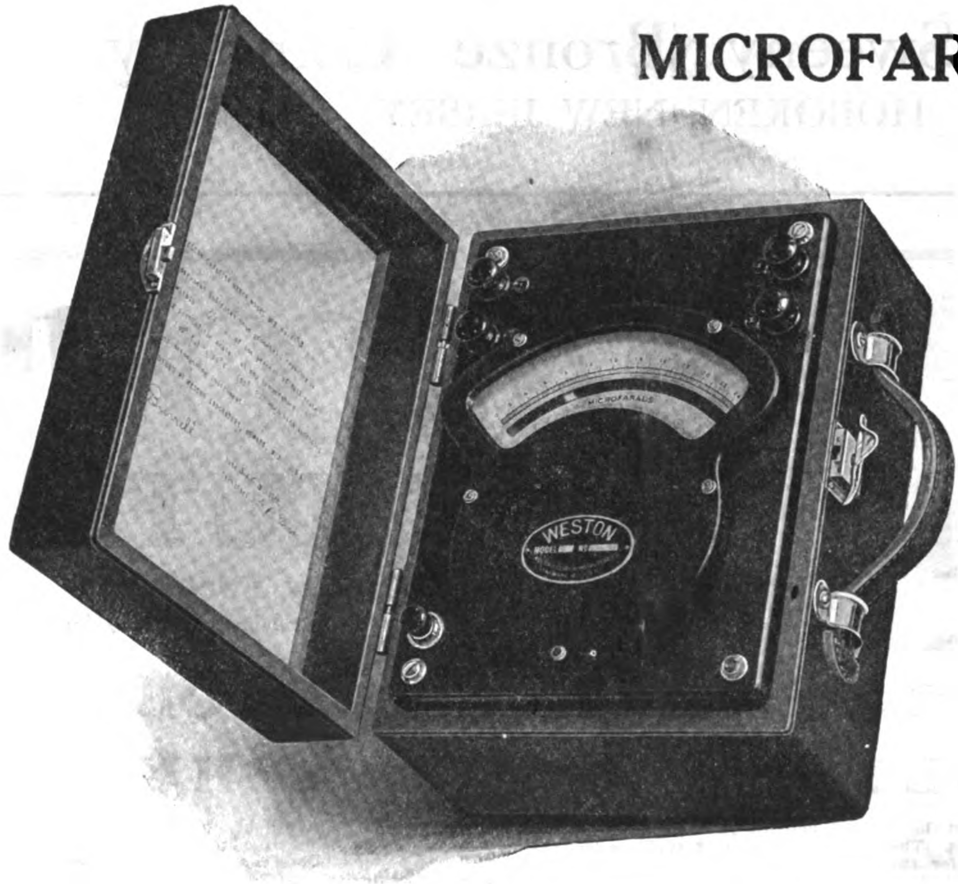

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The Wireless Age

Edited by J. ANDREW WHITE
E. E. BUCHER, Technical Editor

Vol. 6 No. 8

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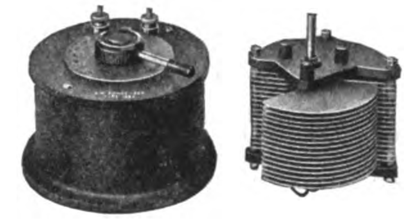

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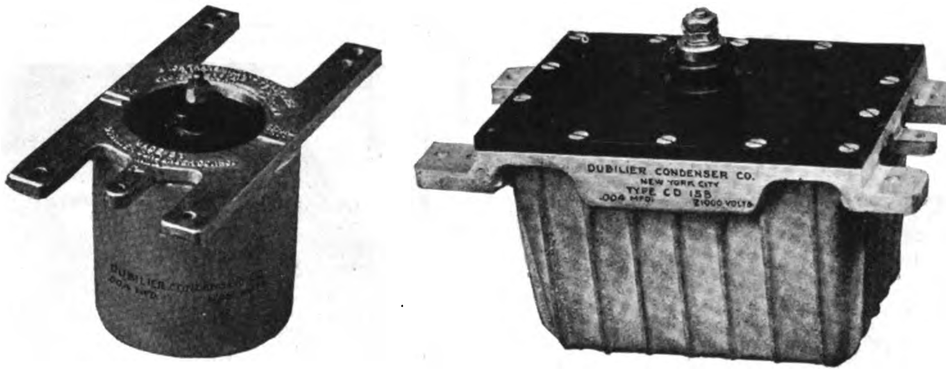

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Aircraft Wireless

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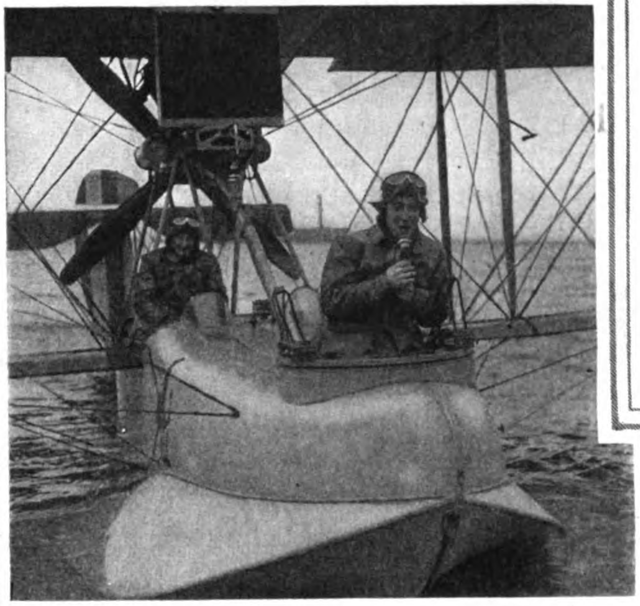

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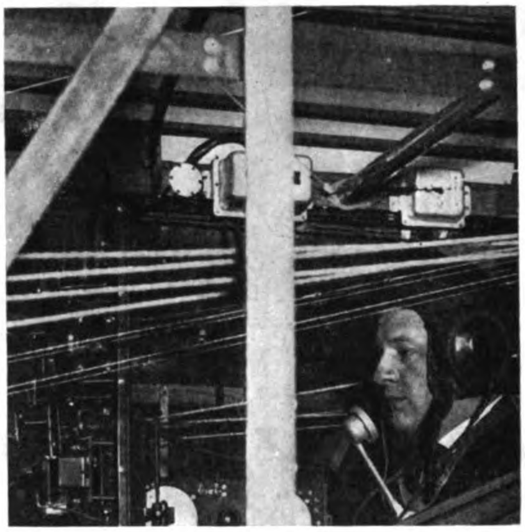


To the left: Gunner H. Leaver at the wireless phone on one of the craft of the aerial coast patrol, which in peace time is employed in locating vessels in distress or in response to any coast alarm

Above: A close-up view of the U. S. Navy's latest flying boat, F-5-L, showing the radiophone installation and the operator

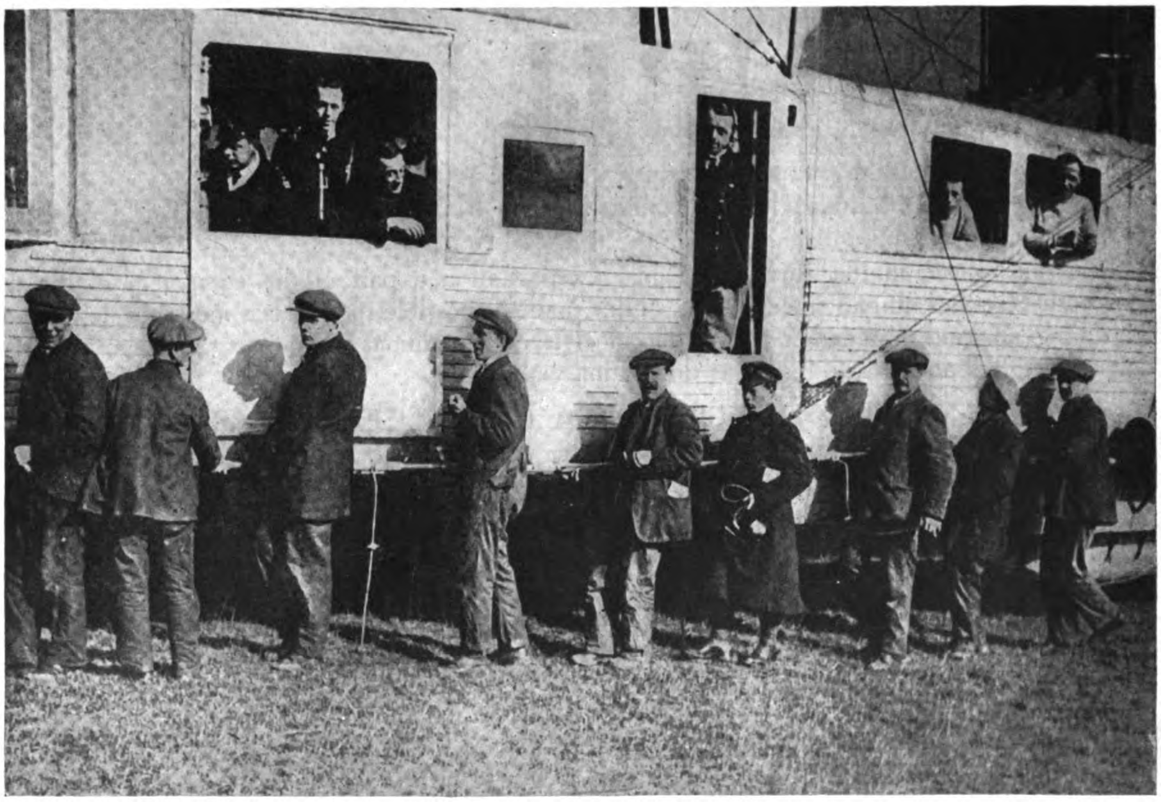


Photo: Intl Film

Launching the world's greatest airship in England; the operator may be seen at the door of the wireless cabin on the right

Vol. 6. No. 8. May, 1919

THE WIRELESS AGE

WORLD-WIDE WIRELESS

Wireless Carries Voice Across the Atlantic

ROBERT WELLES RITCHIE, correspondent, was the first to make public the announcement that the human voice traversed the Atlantic at 7 o'clock on the morning of March 19.

After many months of preliminary experiments in long-distance telephony, a Marconi engineer in a wireless hut at Clifden, Ireland, at that hour, called "Glace Bay."

Instantly the answer came.

"Glace Bay talking."

From that moment on, continuously, Clifden communicated with Nova Scotia, the voices carrying strong and clear all day.

There were no sentimental speeches about the marvel of God's work, but the technical engineers talked about improvements of the system which thus carries man's voice across the Atlantic as readily as between New York and Hoboken.

"Our experiment was a complete success," said General Manager Bradfield, of the English Marconi Company. "Transmission was absolutely instantaneous, and the voices were as clear as over the telephone. After the first messages were exchanged, conditions were so perfect that our engineers continued their conversations all day, saving the delay of writing their comments and recommendations regarding improvements. I am sorry I am unable to give a detailed account at this time."

London first heard the news when Godfrey Isaacs, managing director of Marconi's Wireless Telegraph Co., Ltd., made the simple announcement at a dinner of the American Chamber of Commerce:

"Today we made experimental tests of wireless telephony between Ireland and Nova Scotia. They were completely successful. I look forward to the time, in the near future, when you gentlemen can talk to your home office as easily as with any London address."

Later, according to Mr. Ritchie, Marconi himself observed:

"Within three months you, from your hotel room in London, will be able to call any New York telephone number and get it inside of fifteen minutes, and then talk for three minutes for five dollars."

Though detailed information regarding wireless telephoning between Ireland and Canada is withheld for the present by the Marconi Company, the transatlantic wireless telephone promises to be an astonishing success and that the first efforts to talk through the air were much more successful than the first attempts at wireless telegraphing.

The establishment of a regular system of commercial wireless telephony from New York to London is believed to be now merely a question of time, and before long Sydney, Australia, and the furthest parts of the earth will be placed on the aerial exchange.

On March 20 the U. S. Navy Department also announced that one-way wireless telephone conversations were held between the Naval Radio Station at New Brunswick, N. J., and the American transport George Washington throughout her voyage from New York to Brest.

The messages were sent from the station at New Brunswick, erected by the American Marconi Company before the war, but which was taken over by the Government and has since been under naval operation.

The George Washington received wireless telephone messages and replied to them by wireless telegraph, not having a radiophone apparatus for sending messages over long distances. One of the messages sent by wireless telephone to the George Washington was from Secretary Daniels. President Wilson listened to the wireless words of Mr. Daniels but was unable to reply vocally.

The new messenger boy
—*O. S. Williams in the N. Y. Journal*

British Record in Technical Development Criticized in London

AN EDITORIAL in the London Electrician credits American inventiveness with many of the advances in wireless and takes England to task for her lack of contribution to the art on a scale of equality with other nations. In opposing control of radio by the British Government, the editorial observes:

"In view of the immense volume of progress in all branches of technology with which the private investigator must be credited, it would seem that great harm would result from hasty decisions to debar him from wireless telegraphy. No amount of liberty for established firms could compensate for the extinction of the independent worker; in fact, his extinction would assist these firms to become great monopolies.

“Our national record in wireless telegraphy, apart from the finanacial side, is a sorry one. None of the new ideas that have revolutionized the subject during the past seven years can be regarded as having their origin or full development in this country. The conception of beat-reception is American. The three-electrode thermionic relay is American. The method of generating oscillations by aid of three-electrode relays was invented (probably independently) in Germany and the United States. The control of large high-frequency currents by magnetic relays is likewise of German and American origin. The multiplication of frequency by aid of the properties of iron is French, Italian and German. The success in high-frequency generation by alternators is American, French and German. Even the design of the valves which we used by tens of thousands in the war is not native; we have been the humble copyists of the French in this, and, according to some accounts, second rate in that capacity. The theory of the operation of the circuits is mainly due to French and Italian perspicacity. Nearly all amplifier design and development is French and American. Our main successes in this subject during the war have been in the improvement in detail of wireless telegraph apparatus, and in this we may probably be credited with having done exceedingly well; but the fact remains that no novelties of the first order of importance arose in the work done in this country.”

ANOTHER ONE WILL BE ALONG IN A MINUTE
OH JOHN WE JUST MISSED THE BOAT
BAD
MARS
AIN'T IT NICE HARRY THEY JUST GOT THE WIRELESS PHONE FINISHED IN TIME
HELLO — THAT YOU MARS? — SAY OLD MAN SAVE ME A TABLE FOR SIX — FOR SATURDAY NIGHT —
ANOTHER BAD BUST ON THE MARS HIGH-WAY
TWO PLANES COLLIDE ON THE MILKY WAY — 6 HURT IN CRASH
FAY KING '17

Wireless possibilities!

—*Fay King in the N. Y. Journal*

Photographic Recording Method to Speed Up Wireless Transmission

WIRELESS messages can be received and recorded at greater speed, as a result of a new photographic device now being used at the naval station at Otter Cliffs, near Bar Harbor, Me. Although the instrument is not immune from the effects of static “strays,” it has successfully recorded messages at high speed regardless of strong static interferences that, without its aid, would have baffled the receiving operator. It is said that this machine has frequently recorded at the rate of 400 words per minute and, on one occasion, 600 words.

Up to this time the most rapid method of recording radio signals has been by dictaphone, but the phonographic method has never yet approached the rate of 600 words per minute, so the new instrument has hung up a new speed record.

Speedy sending and receiving can condense the traffic; a greater volume can be sent with a minimum number of stations. When it is remembered that a pair of wireless stations—one in Europe and one here—can easily cost $2,000,000, the item of keeping down overhead charges by rapid sending will be easily appreciated.

Expert operators have been known to receive thirty-five words per minute for a short time under perfect conditions, but average reception has been fifteen to twenty words per minute, or 1,000 words per hour.

The photographic recorder in operation at Bar Harbor has repeatedly recorded regular traffic schedules ranging from 1,000 to 7,000 words without interruption, and at a speed of forty to fifty-five words per minute every word is perfect and easily and quickly read. It is used supplementary to the ordinary type of receiving set.

The mechanism is based on comparatively simple electrical engineering principles. A lightweight mirror “flutters” in electro-magnetic tune with the minute electric impulses coming from the receiving antenna. The duration and extent of the mirror's oscillations vary according to the dot, dash, or silence of the sending station. This mirror reflects a beam of light on the moving sensitized tape. This tape, propelled by an electric motor progresses up and down through the vertical pipes which contain the developing and fixing chemicals. Automatically the tape enters the developing fluid and then the hypo fixing bath; then it is washed in running water and is dried by electric heat assisted by forced draft—all invisibly effected inside this single machine. Like the tape from a stock-ticker, the message pours out into a basket. In rapid receiving there is an average of one word for every inch of tape. The receiving operators can read the record at a speed of 50 to 100 words per minute.

The time to record, develop, fix, wash, and dry the tape is from two to four minutes. The rolls of tape are 1,000 feet long and a continuous message of 10,000 words can be recorded without reloading the machine.

Submarine Jazzes for Airship by Radiophone

OUT of the depths the strains of a popular tune were wafted through the air to the radio telephone apparatus at the Aeronautical Exposition in Madison Square Garden, New York, on the afternoon of March 7.

The lively tune came as a striking contrast to a conversation that had just been completed with the naval airship, L. S. B., flying over the city, navigated by Captain Noble E. Irwin, director of naval aviation.

A large crowd had gathered around the radio space at the Garden, attracted by the novelty of listening to a man talking aboard an airship floating in space three miles away.

In the airship Gunner Lever was telling the crowd in Madison Square Garden the interesting points the airship was passing, when a gruff voice impinged itself upon the oratorical tones of the aerial gunner. “Say,” it said, “when are you fellows going to get through? This is the Submarine 249, in the North River, off Twenty-third Street. We are tired of listening to that voice. We are going to give you a tune for a change.”

Then, to the astounded spectators the loud speaking telephone, which was being used for the demonstration, reproduced the newest dance music with all the flourishes of Lieutenant Europe's famous jazz band.

Predicts Business Conducted with South America by Radiophone

BUSINESS men of America soon may be placing and taking orders in South American ports by wireless telephone, Edward N. Hurley, chairman of the Shipping Board, told a conference of the Pan-American Union on March 14.

Outlining preparations that are being made to put new shipping in the South American trade, Mr. Hurley foresaw the time when business men of New York would be sitting back quietly in their offices talking with their clients in Buenos Ayres, Rio Janeiro and Valparaiso by wireless telephone as easily as one calls up a neighbor in New York.

Twenty-two 12,000 ton vessels are being constructed for the South American trade, Mr. Hurley said. They will be equipped as comfortably as the finest ocean going palaces which ply in the Atlantic. An additional twenty-two vessels of smaller tonnage are being built for the same trade.

Wireless Service to Holland Required by Cable Interruption

THE British Administrator announced early in March, through the Commercial Cable Company, that owing to the interruption of several wires in the cables to Holland an auxiliary wireless service has been provided pending completion of repairs. Messages intended for transmission by wireless, the announcement added, should be marked by senders "via wireless," and these words should be included in the service instructions. The rate is the same as by cable.

Wireless Guide for Transocean Fliers

LONDON advices relative to transatlantic flight state that at least one of the airplanes that will compete for the transatlantic flight prize will be navigated from wireless information, supplied every half-hour or so by British Air Ministry officials. The pilot will send out an inquiry, and from the direction from which his message is received wireless stations will calculate his exact position. This will be relayed by wireless to the pilot in a few minutes.

The British "Directional" wireless apparatus has been developed during the war, and the Air Ministry claims its instruments are far in advance of those of any other nation.

"Listening at their instruments in shore stations," said an English wireless officer, "hundreds of miles from the spot where an airplane is battling its way across the ocean, our operators will hear a short, prearranged code from the navigator at every coast station.

"Possibly a number of battleships will record the messages and instruments now perfected will point out in each instance the exact direction of the airplane.

"There will be a hasty conference between the stations, and within five minutes the navigator will be able to mark on his map exactly what his position was when he sent his inquiry.

"Fitted with 'directional' wireless and a good compass the airplane will be able to steer through fog or clouds without getting more than a trifling distance off its course."

Canada also promises close co-operation so that aviators engaged in the transatlantic flights will never lose touch with their friends on shore. Friendly voices will advise them and their progress or difficulties en route will be reported in their own words and heard in their own voices by eager watchers. The Marconi wireless telephone will make this possible, says an announcement given out by Thomas Robb, of the Canadian Company. The flight will be made direct from the west coast of Ireland to Newfoundland. There are thirty Marconi stations on the west coast of Ireland and Scotland and an equal number around the central works at Gaspe Bay.

"We have the situation thoroughly in hand now," said Mr. Robb. "We have taken every precaution, so the risk to the aviators will be considerably modified. Through steamships on the ocean and land stations we will be in touch with them all the way.

"The airplane will have the wireless telephone and telegraph sets. The ship will have the wireless telegraph sets, enabling the aviators to receive news as to fog and weather and also be told where their exact landing place is. Newfoundland is a splendid wireless base, and the government there is co-operating with us."

Photographic device for printing wireless messages on tape with a speed of 400 words a minute

Method of Overcoming German Jamming Disclosed

POWERFUL German wireless installations were used to drown out messages among the Allies as part of a deliberate policy. How our navy, on entering the war, overcame this interference was described by E. F. W. Alexanderson at the April meeting of the Institute of Radio Engineers. An abstract of his paper appears elsewhere in this issue.

Dr. Alexanderson described his device as a "barrage receiver," which permits an operator to turn a deaf ear, electrically as well as literally, to all messages which may come through the ether except that particular message which he desires to hear. The invention was kept secret until the end of the war at the request of the army and navy. It has been demonstrated successfully and is now in navy use.

"The object of this development," said Alexanderson, "was to provide means for neutralizing the overwhelming intensity of the transmitted signal so as to make the receiving set sensitive to the faint impulses of the distant signal. Popularly speaking, the correspondent equivalent in sound waves would be to have an ear which could be so adjusted that a person could stand close to a steam whistle without hearing the whistle, but at the same time listen to a person speaking from a distance of a few hundred feet."

Bogota to Have Powerful Marconi Station

ANOTHER COMMUNICATION link with South America has been announced by the State Department at Washington. Marconi's Wireless Telegraph Company, Ltd., of London, the report states, has concluded a contract with the Colombian Government for the erection of a powerful wireless station at Bogota.

Millionaire's Ranch to Use Wireless and Airplane

J. PIERPONT MORGAN has engaged Erhardt Schmitt of Ansonia, Conn., to pilot the manager of his 250-mile tract of wheat fields at Hardin, Mont., in an airplane. Thus Mr. Morgan solves the problem of getting speedily to any part of the ranch. It is believed Schmitt will be the first man to pilot an airplane as agricultural equipment. The airplane will be equipped with wireless, and stations will be established at intervals on the ranch.

On a ranch the size of Mr. Morgan's it was impracticable to build roads to enable the manager to get around the ranch in an automobile, so the owner adopted the airplane, which will save much time and undoubtedly will prove to be less expensive.

Mr. Schmitt is a wireless operator, and so the manager will be able to keep in touch with every section of the territory. Mr. Schmitt was discharged recently from the United States Army. He was a First Lieutenant in the American Air Service in France.

Time Signals Changed on Schedule

IN accordance with the daylight saving law, daily telegraphic time signals are now sent from the United States Naval Observatory at noon Washington summer time, i. e., at four hours Greenwich mean time.

Daily noon and night radio time signals are sent from naval radio stations on the Atlantic coast at four hours and fourteen hours Greenwich mean time (noon and 10 p. m. Washington summer time), except Washington, which will remain, as formerly, five hours and fifteen hours Greenwich mean time (1 p. m. and 11 p. m. Washington summer time), and from the stations on the Pacific coast at seven hours and seventeen hours Greenwich mean time (noon and 10 p. m. San Francisco summer time).

Only American Paper in Germany Has Wireless News Service

SOLDIERS of the Fourth Army Corps are responsible for the "Only American Newspaper Published in Germany," as The Fourth Corps Flare is proclaimed, being published at Mayen every Friday, with wireless news from all parts of the world up to the time of going to press.

The biggest headlines, according to a dispatch from Coblenz, are devoted to speculation as to when the return trip to America will be made, and news of the Peace Conference, interior happenings in Germany, of the United States, France and England, is picked up from the air as needed to complete each edition.

The editor of the Flare is a well known amateur, Wallace W. Smith, of the Radio Club of Louisville, Ky., now a Second Lieutenant with the A. E. F.

Doctors Aboard Troopships Consult by Wireless

ANOTHER instance of the practicability of diagnosis, treatment and medical consultations by wireless at sea was recorded in the westward passage of two transports early in March.

Sierra in mid-ocean received a wireless telegraph message from the captain of the British steamship Pollac, saying that a member of his crew had been taken sick suddenly. The message gave symptoms and asked for diagnosis and treatment. Further messages brought a clearer knowledge of the case to Lieut.-Commander A. E. Younie, of the Medical Corps of the army, chief surgeon aboard. Treatment was ordered and hourly reports were made by the captain of the merchantman to the doctor a hundred miles away. In two days the man had showed marked improvement, and when last reported was recovering rapidly.

The wireless telephone was also used for a consultation of all the doctors aboard the Sierra and those aboard the Powhatan, another troop transport. The two vessels were fifteen miles apart, at a point about five hundred miles north of the Azores, when a consultation about influenza cases developed on the Powhatan was determined on. Six doctors, via wireless telephone, "attended" the conference, the cases being discussed as freely as if the physicians were gathered in one room.

"It doesn't take much imagination to see what a wide field of possibilities the wireless opens up to the medical profession," Lieut.-Commander Younie said. "America is building up an enormous merchant marine. The greater portion of the ships will not be large enough to carry doctors, but in an emergency the captain of one of these ships, using her wireless set, can always call upon expert medical advice, either from ashore or from the doctors aboard the larger ships."

Liberian Station at Monrovia No Longer German

LIBERIA has advised the American Government that the former German wireless station at Monrovia has been opened with a Liberian staff for general public service.

Canadians Install Commercial Wireless Telephones

THE wireless telephone is to be put to practical commercial use in Canada.

Instruments are being installed in the offices of the Montreal Board of Trade and these will enable brokers to talk with Kingston, Ottawa, Three Rivers and Quebec.

It is expected that ultimately conversations will take place between the Board of Trade and Ireland over the Marconi Company's wireless.

Eight Radio Compass Stations for New England

THERE will be eight radio compass stations established along the New England coast, according to a statement made by Rear Admiral Spencer S. Wood. Deer Island station has been repaired and made over. North Truro on Cape Cod and Otter Cliff, Me., are working.

Argentina and Paraguay Make Radio Exchange Agreement

THE Governments of Paraguay and Argentina will exchange radio telegraphic service. An agreement has been signed by the respective representatives of the two Governments. Wireless telegraphic communication is a government monopoly in both countries, and it is hoped that the arrangement will result in much better service for Paraguay than it has enjoyed heretofore.

Naval Operators to Be Taken Off Merchant Ships

GOVERNMENT wireless operators will be removed from all merchant vessels as soon as the ships are returned by the shipping board to their owners, is the announcement made by the hydrographic office at the Maritime Exchange upon the receipt of a communication from the Navy Department.

The apparatus was installed by the Navy Department and will be permitted to remain intact on the vessel for a time, but private interests operating the boat must furnish their own operators. If, however, the company is unable to maintain service, they may employ the navy operators until efficient ones can be had.

A Magnetic Detector of Radio Frequency Oscillations

CLAIMING to have discovered that the super-position of a high frequency current upon an iron core already excited by a low frequency current, reduces the area of the hysteresis loop for the low frequency current, G. W. Elmen has recently disclosed the circuits of a wireless receiving system based upon this principle. His explanation of the phenomenon is that the high frequency oscillations seem to shake up the iron molecules, thereby reducing the force required to set them into motion. Low frequency energy is thus saved, for the energy required to agitate the molecules is supplied by the high frequency source.

Currents of very high frequency are not necessary to carry out the principle of Elmen's receiving system, for it has been found that if low frequency current of approximately 15 cycles per second is employed, another current of 60 cycles per second is sufficient to cause the reduction of the hysteresis loop on the low frequency side to practically zero. If the current of lower frequency is then increased, the high frequency current must be increased correspondingly, and may be made very much higher than the lower frequency.

By selection of suitable iron and properly constructing the coil Mr. Elmen claims it is possible to make the ohmic and eddy consumption losses so small that they will be wholly due to hysteresis, thereby enabling the most effective results to be secured from the system.

In magnetic oscillation detectors use has heretofore been made of the suddenly induced effects produced in a receiver circuit when the hystersis cycle in a body of iron is brought partially or wholly into phase with the magnetizing force by the received high frequency oscillations. This sudden breaking down of the magnetic condition gives a sharp click or signal in the receiver or translating device which is independent of the frequency of the low frequency magnetizing force. Mr. Elmen's method of reception differs, in that he makes use of the change in the hysteretic energy which must be supplied by the low frequency source when high frequency oscillations are received. Since the change in hysteretic energy is equivalent to a change in the effective resistance of the coil surrounding the iron, any method for indicating or measuring this change in effective resistance may be employed to detect the presence of the radio frequency current. Accordingly, the inventor makes use of Wheatstone's bridge as shown in figures 1 and 2.

Figure 1 shows one circuit for detecting radio frequency currents; figure 2 is a modification, and figures 3 and 4 show forms of coils which have been found useful.

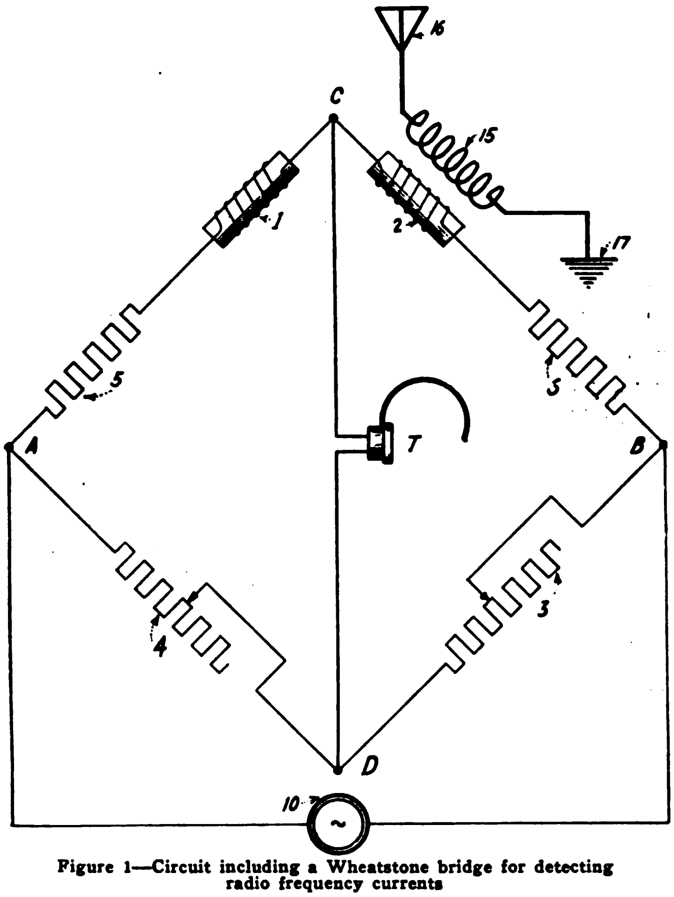


Figure 1—Circuit including a Wheatstone bridge for detecting radio frequency currents

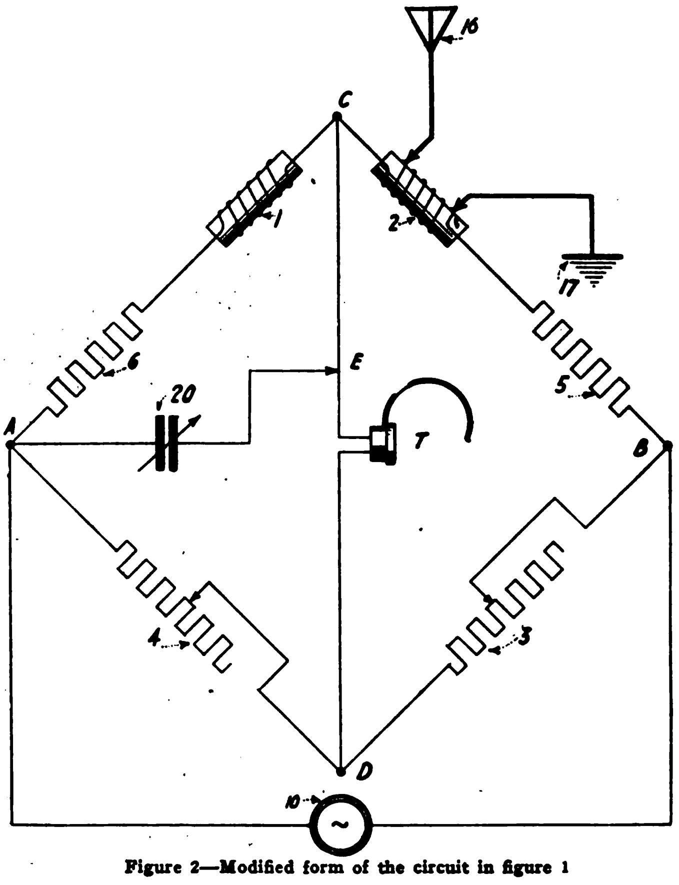
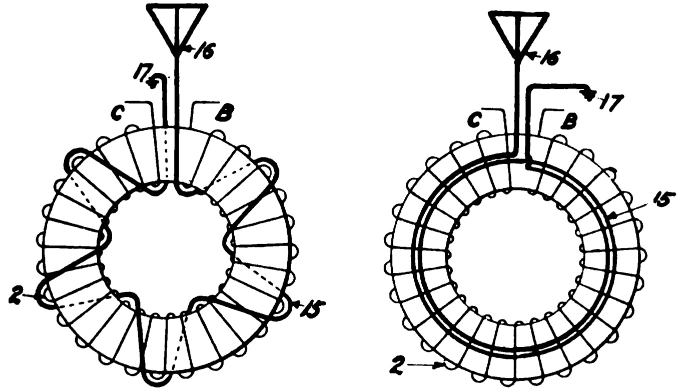


Figure 2—Modified form of the circuit in figure 1

In figures 1 and 2, the iron core coils 1 and 2 are made as nearly identical as possible, and of such form that the ohmic and eddy losses are very small. The cores should be of low coercive force and high remanence. The two other arms of the bridge contain non-inductive resistances 3 and 4 which should be adjustable. Connected to the terminals of the bridge A and B, is the source 10 of alternating or pulsating current of low frequency. Across the terminals CD are connected the head telephones T. Inductively connected to the coil 2 is the coil 15 which is the inductance element of the antenna current.

The circuit in figure 1 operates as follows: The bridge is balanced both for ohmic resistance and for reactance, so that no current flows through the phones T. In order to assist in this adjustment it may be desirable to place the non-inductive resistances 5 and 6 in the branches containing the coils 1 and 2, but these will not always be necessary, for if the coils 1 and 2 are made as nearly identical as possible, any slight difference in them can be adjusted by means of the resistances 3 and 4. Under these conditions, low frequency oscillations will pass continually through the network, and the iron cores of the coils 1 and 2 will be caused to pass through a magnetic cycle, and energy will be consumed because of the hysteresis of the iron. Since the bridge is balanced, however, no current will pass through the translating device T.



Figures 3 and 4—Coils used in the Elmen magnetic detector

When high frequency oscillations are impressed upon the coil 2 by means of the antenna coil 15, the magnetic condition of the core of this coil will be suddenly brought into phase, wholly or partially, with the magnetizing force. As a result the bridge will be thrown out of balance and an indication will be given at T. In general this lack of balance is due to two factors, the first of which may be designated as e_1 and is due to the change in the flux in the coil 2, giving rise to a sudden induced electromotive force, which causes a flow of current through the telephone T. In addition to this effect there is a second effect which may be designated as e_2, and is due to the reduction in the hysteretic energy absorbed as a result of the hysteresis cycle through which the iron is carried by the low frequency source 10. This reduction in the amount of the hysteretic energy represents a reduction in the amount of energy which is consumed in the coil 2, and is therefore equivalent to a reduction in the effective resistance of the coil. This change in effective resistance produces a lack of balance in the bridge, and consequently there is a flow through the translating device T of current from the source 10.

It will be noticed that the first effect e_1 corresponds to the effect which is ordinarily made use of in magnetic detectors as heretofore constructed, and that the effect produced in T is simply a sharp click due to the sudden induced electromotive force. The second effect e_2, however, is independent of this, and is due to a lack of balance in the bridge, as a result of which there will be heard in the telephone receiver T a note which corresponds to the frequency of the generator 10, which will be heard as long as the coil 2 is subjected to the high frequency oscillations impressed upon it by the antenna.

Any other network which is adapted to measure inductances may be used in this system. An example is shown in figure 2, in which a variable condenser 20 is connected from the point A to some point E on the branch CD, which in this case has a small resistance. The bridge is brought into balance either by an adjustment of the capacity 20 or by an adjustment of the point of contact E. Having brought the bridge into balance, no current from the generator 10 will flow through T, but upon the receipt of high frequency oscillations, the bridge will be thrown out of balance and a signal will be received at T.

In order to obtain low coercive force and high remanence, it is desirable to use for the two arms of the bridge a closed core, as shown in figures 3 and 4. Furthermore, in order to reduce the eddy currents, these cores should be laminated or stranded. In figure 3 the high frequency coil is shown as wound upon the core in the same manner as for the coil 2. In figure 4 this antenna or high frequency coil is shown as being wound parallel to the core and preferably embedded in its center. It has been found that in this case the effect of the high frequency oscillations in reducing the hysteresis loss is as effective as in the coils shown in figure 3. Furthermore, it will be noticed that in figure 4 the coil 15 is at all points at right angles to the coil 2, and in consequence there is no induced effect of the coil 15 upon the coil 2.

The frequency of the generator 10 may be varied between wide limits. If the translating device T is to be the ordinary telephone receiver, then it is obvious that the frequency should be within the limits of audibility, and in this case a frequency of about 800 is very good indeed. If the translating device is a vibration galvanometer or some such device, the frequency may be made either lower or higher than the limits of audibility, this being determined by the frequency for which the device is adapted to be used.

Negative Resistance Vacuum Tube as an Amplifier and a Beat Receiver

FULL description of the pliodynatron devised by A. W. Hull appeared in the June and August, 1918, issues of The Wireless Age. Although this detector has not been employed commercially, it involves certain operating characteristics which have aroused considerable interest and incidental argument amongst wireless engineers. Numerous circuits have been devised, but Mr. Hull declares that those shown in the accompanying figures 1 and 2 give very marked amplifications and selectivity and, furthermore, permit the reception of continuous oscillations by the so-called heterodyne principle.

Throughout a certain range of adjustment, the Hull tube acts as a true negative resistance. An externally applied E.M.F. under proper adjustments of the tube will actually set up a current in the circuit in the reverse direction.

The circuits shown contain an inductance and capacity in the negative resistance circuit, making it resonant to the frequency of the incoming signal, with the result that when the incoming oscillations are impressed upon the grid or controlling circuit, the value of the negative resistance will change so that similar oscillations are produced in the local circuit. This results in amplification and marked selectivity. An audio frequency tuning circuit is provided which affords additional tuning means; and through the medium of a resistance 18 of figure 2, sufficient energy is transferred from the circuit containing the negative resistance to the control circuit to compensate for the losses in that circuit and the antenna circuit.

The heterodyne effect is obtained by causing the circuit containing the negative resistance to oscillate at a slightly different frequency from that of the incoming signal.

In the diagram, 6 is a filament cathode surrounded by the grid or controlling member 2; 4 is the so-called anode and 5 a third electrode which is connected to the positive terminal of a battery 8.

In the operation of this device a definite positive potential is applied to the anode 4 by means of a battery 7, the cathode being considered as at zero or earth potential. When the cathode is heated to incandescence, electrons flow from the cathode to the anode. If the third electrode 5 is at the same potential as the cathode no electrons will be received by it, but if a small positive potential less than that of the anode is applied to the third electrode, a portion of the electrons will pass through the anode and reach the third electrode.

The velocity with which these electrons will strike the third electrode will depend upon the potential between it and the cathode. If this potential is increased, the velocity will increase until the electrons, striking the third electrode, are able, by their impact, to liberate secondary electrons. These secondary electrons leaving the third electrode will be attracted to the more positive anode. As the potential is increased, a point will be reached at which the number of secondary electrons leaving the third electrode will begin to decrease. As the potential of the third electrode is increased beyond this point, the current will continue to decrease and *may even reverse* in direction up to a point where the potential of the third electrode approaches that of the anode. Thus it will be apparent that the device has a working range through which it has a negative resistance characteristic; that is, over which the current in the external circuit, between the cathode and the third electrode, varies inversely as the potential between the electrodes.

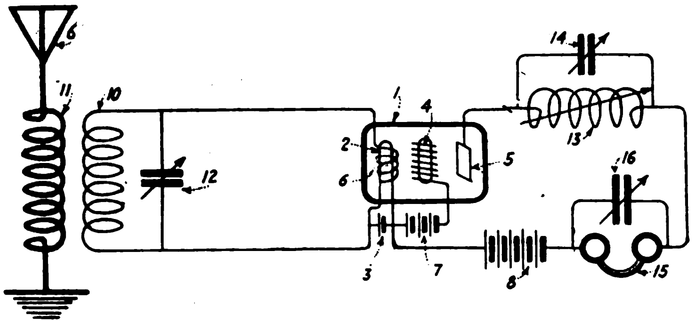


Figure 1—Circuit using the heterodyne principle to secure increased amplification and selectivity in receiving

If a constant potential is applied to the third electrode, by means of the battery 8, of such value that the device will operate as a negative resistance, there will be a constant flow of current in the external circuit. If, however, a variable potential is applied between the cathode and the discharge controlling member 6, the number of electrons which leave the cathode and reach the third electrode will be varied, and the current in the external circuit will be varied accordingly; that is, if the member 6 is made more positive, the flow of electrons to the third electrode will increase, and if the member 6 is made more negative, the flow of electrons will decrease and a small change in the potential of the member 6 will be capable of producing a large change in the current between the cathode and the third electrode.

In utilizing this device for the reception of wireless signals, waves which are received upon the antenna 9 are impressed upon the discharge controlling member 6 by means of an oscillating circuit comprising an inductance 10 which is coupled to the antenna inductance 11 and a variable condenser 12. In the external circuit between the cathode and the third electrode are placed a variable inductance 13 and a variable capacity 14 in parallel. This circuit may include the usual telephone receiver 15 shunted by a variable condenser 16.

In receiving signals, by this system, the inductance 13 and capacity 14 may be so adjusted that the circuit is capable of oscillating at frequency equal to that of the received signals. The value of the negative resistance is adjusted to such a point that the circuit is near a point of instability or a point where oscillations will begin. When the potential of the member 6 is varied by received oscillations, the value of the negative resistance will be changed sufficiently so that the circuit will start oscillating. Under these conditions the amplification of the received signals will be assymetric and the resulting current will operate the telephone receiver.

Without the condenser 16, the circuit would tend to produce oscillations of an undesirable audio frequency. This condenser 16, however, may be so adjusted as to prevent the setting up of audio frequency oscillations, or may be so adjusted as to produce audio frequency oscillations of a frequency equal to the group frequency of the incoming waves. The final adjustments of the system may conveniently be made by varying the value of the negative resistance, which is done by regulating the temperature of the cathode 2.

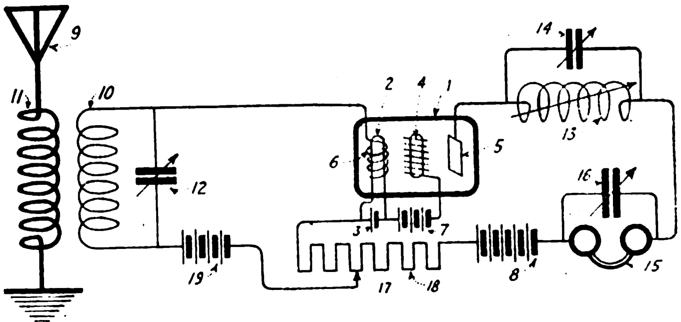


Figure 2—Another form of figure 1 which permits reception of continuous oscillations by the heterodyne principle

In order to secure the highest degree of amplification in the system described, the positive resistance of the circuit should be approximately equal in value to the negative resistance.

In the arrangement shown in figure 1, the negative resistance compensates for the losses in the positive resistance of the circuit between cathode and third electrode. In the modification shown in figure 2, means are indicated for compensating also for the losses in the resonant receiving circuit and the antenna. In this case the discharge controlling member 6, instead of being connected directly to the cathode 3, is connected to a suitably selected point 17 on the resistance 18, which is in series with the negative resistance. The voltage supplied to the device by the battery 8 is of such a value that the current in the circuit is negative; that is, positive electricity or its equivalent flows from cathode 2 to the third electrode 5 across the evacuated space and thence through the battery 8 and resistance 18 back to the cathode. If the potential of member 6 is made more positive, the current through the resistance 18 will increase, and thus the potential of the point 17 and of the member 6 will be still further increased. By means of this resistance coupling, energy is fed back from the negative resistance circuit to the resonant receiving circuit and by properly adjusting the point 17, the amount of energy thus transferred may be made sufficient to compensate for the losses in the receiving circuit and in the antenna without producing oscillations.

An anonymous donor has deposited with the Institute of Radio Engineers, New York, the sum of $10,000, the principal to be preserved in perpetuity and the income each year to be awarded to that member of the institute who shall have made the most important contribution to the art of radio during the preceding year. This, in addition to the Institute's Medal of Honor, should spur forward American students in the radio field.

Exhausting Vacuum Tubes

READERS of The Wireless Age who are identified with the manufacture of vacuum tubes may be interested in the process of evacuation devised by H. D. Arnold. The method shown in figure 1 provides particularly for heating the exterior of the tubes during the exhausting process; also for heating one or more of the inclosed electrodes by the passage of an electric current and also for heating another electrode by electronic bombardment due to the application of a local E.M.F.

In the drawing, figure 1, thermionic repeater elements 2, each having the customary filamentary cathode 3, grid 4 and anode 5, are inclosed in an oven 6 which may be electrically heated by a resistance element 7 connected to a source of current 8. The glass containing vessels 9 of the elements 2 have tubular extensions 10 connected to a main tube 11 leading to an exhaust apparatus 12, such, for example, as a Gaede molecular pump, connected to a source of motive power 13. The terminals of the electrode elements 3, 4 and 5 are brought out through apertures in one of the walls of the oven 6, so as to be readily available for test purposes and for the application of any desired electromotive force.

A suitable number of windows 15 are provided in the front of the oven 6 so that the tubes 2 being exhausted may be observed during the evacuation process. The filaments 3 are connected in series with a source of current 16 and a variable resistance 17.

The process of exhausting the vessels 9 is as follows: The pump 12 is started and the temperature of the oven 6 is gradually raised until it has reached approximately 350° C. The purpose of this heating is to drive out the gases occluded by the walls of the vessel 9. After the temperature of the oven has risen to about 250° C., the filaments 3 are brought to incandescence by current supplied from the source 16, which is raised to a value approximately 10 per cent greater than the current normally to be used in the operation of the completed device. A potential difference is thereupon successively applied to the terminals of the electrodes 4 and 5 by means of a test clip 20 connected through the potentiometer 21 to a direct current source 22 of about 220 volts output. The filament 3, being connected to the negative terminal of the source 22 as shown, and the test clip 20 being connected to the positive terminal of the source 22, there will result an electron discharge from the cathode 3 to the electrode 4 or 5, to which the test clip 20 is temporarily connected. This potential difference is made sufficiently high, through adjustment of the potentiometer 21, to cause an electron discharge of sufficient volume to heat the electrode (to which the test clip 20 is attached) to incandescence. This drives out any gases which may be occluded by the electrode.

The electron discharge, which passes from the cathode 3 to either electrode 4 or 5 when a potential difference is established between them, partially ionizes whatever gas may be in its path. When gas in sufficient quantity is thus ionized, a blue glow results in part or all of the vessel 9, which may readily be observed through one of the windows 15. The intensity of this blue glow depends upon the amount of gas present and upon the current and potential difference impressed between the cathode 3 and electrode 5. For a given current and potential difference, therefore, this blue glow will gradually become fainter as the gas within the vessel becomes more attenuated, until the glow finally disappears.

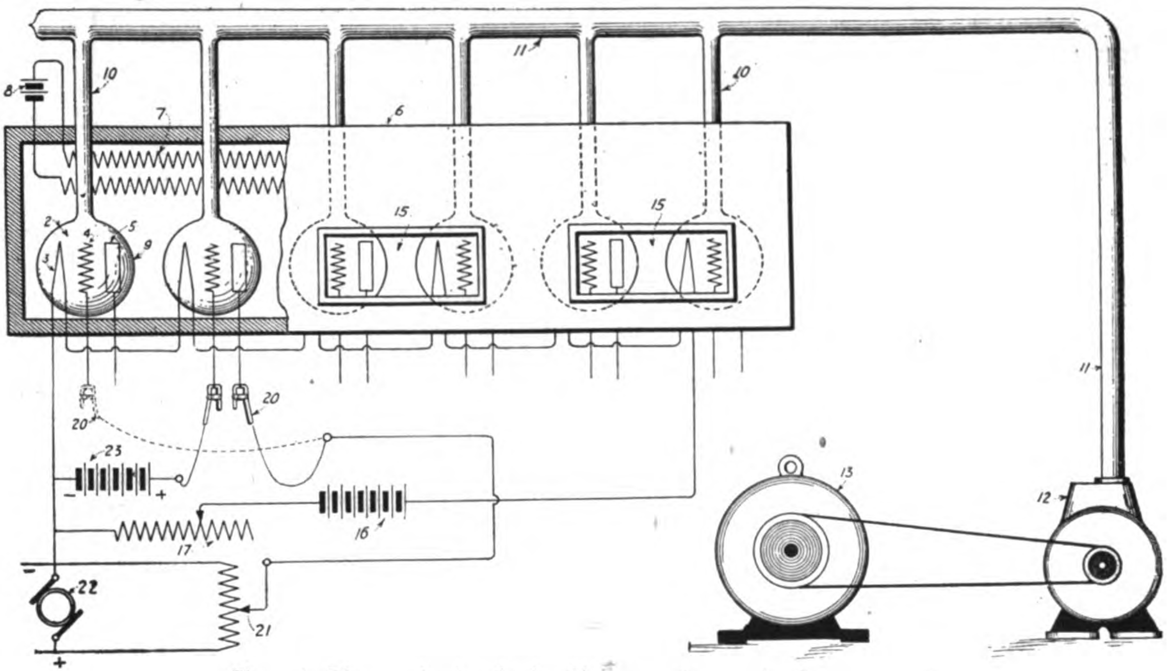


Figure 1—Diagram showing the Arnold process of evacuation for vacuum tubes

When the proper degree of exhaustion is obtained, the tubes are allowed to cool gradually and are sealed off of the pump 12 and given an aging run. This consists of applying the normal heating current to the filaments 3 and impressing the customary operating potential difference between the cathode 3 and anode 5. It has been found that after an aging run of from fifteen to twenty hours duration the repeaters have reached a stable condition and may be relied upon to give constant and uniform results.

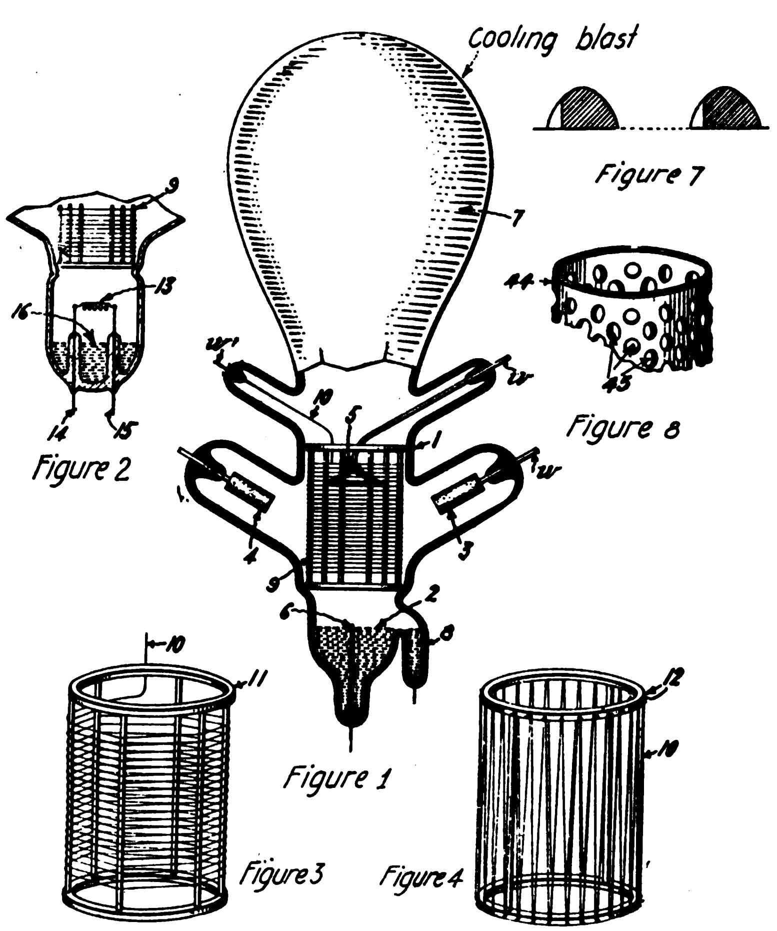
In case the thermionic device to be exhausted is equipped with a grid 4 of very fine mesh, as in the case of a repeater tube designed for voltage amplification, it may be difficult to obtain a current to the electrode 5 sufficient to heat it properly. In such event, it has been found desirable to apply an additional positive potential from a source 23, for example, of perhaps 60 volts output, to the grid electrode 4 at the same time that the positive potential from source 22 is being applied to the anode 5. This increases the flow of electrons to the anode 5, and as some current will also flow between the filament 3 and grid 4, the voltages may be adjusted so as to heat both electrodes 4 and 5 at the same time.

Langmuir's Mercury Vapor Modulator for Wireless Telephony

A METHOD of controlling the output of a radio frequency alternator at speech frequencies for radio telephony is the subject of a recent patent granted to Dr. Irving Langmuir. The control device illustrated in figure 1 comprises a glass or quartz envelop 1 containing a body of mercury 2 (constituting the cathode), and main anodes 3 and 4 which may be made of graphite, tungsten, molybdenum or other highly refractory material.

Above the cathode 2 is an anode 5 from which a constant arc is formed with the cathode. The steadiness of the arc is insured by the conductor 6, of platinum or copper projecting above the surface of the mercury. A condenser chamber of the correct size to give the proper mercury pressure is shown at 7. The arc is started by the small electrode 8; 9 is a grid of tungsten wire placed between electrodes 5 and 2 and the anodes 3 and 4. Suitable constructions for the grid are shown in figures 3 and 4. Figure 8 shows a modified form.

Two circuits for wireless telephony are shown in figures 5 and 6. In figure 5 energy is withdrawn from the antenna at speech frequencies; in figure 6 modulated currents are supplied to the antenna from the radio frequency alternator.



Detailed diagrams of Langmuir's mercury vapor modulator for wireless telephony

In figure 5 the usual antenna 17 is shown containing an inductive coil 18 and a series condenser 19. Electrical energy is supplied by a high frequency alternator inductively coupled to the antenna coil 18. The coil 22 is also located in inductive relation with the coil 21 and has its terminals connected by conductors 23, 24, to the anodes 3, 4 of the control device. The cathode 2 is connected in series with the resistance 25 by a circuit conductor 26, carrying rectified current, to a point of intermediate potential on the coil 22. The circuit represented by conductor 27 connecting the cathode 2 and the anode 5 contains a battery 28 for supplying energy to continuously maintain an arc between these electrodes. This same battery may also be used to start the device by completing a circuit to the auxiliary electrode 8 through the switch 29.

When the arc between the electrodes 5 and 2 is normally operating, energy is supplied by the alternator 20, and successive arcs would ordinarily pass from the anodes 3 and 4 to the cathode in the usual manner. When, however, the grid 9 is negatively electrified to a sufficiently high potential the starting of these arcs is prevented. In order to take advantage of this fact a variable negative potential may be impressed upon the grid, thereby causing variable amounts of energy to be passed by the arc device. As this energy is consumed in the resistance 25, it is subtracted from the energy available for the antenna. In this way signals may be transmitted. For example, a telephone transmitter 30 containing a local source of energy such as battery 31, may be connected to the primary of a transformer 32, the secondary of which is connected to its negative terminal by the conductor 33 to the grid 9. The positive terminal of the secondary is connected by a conductor 34 in series with the battery 35 to the cathode 2. The battery 35 is not absolutely essential, but is desirable as it maintains the grid at a definite negative potential so that the variations impressed by the signaling current vary the grid potential to values above or below the battery potential.

High frequency current in the circuit 33, 34 is damped out by a condenser 36 and the resistance 37. When a voice produces variation in the conductivity of the transmitter 30 the resultant variable current in the transformer 32 is stepped up in potential, superimposed upon the battery potential 35 and thus varies the charge on the grid. The grid, in accordance with the degree of its negative charge, delays the starting of the wave impulses from the anodes as shown diagrammatically in figure 7, the shaded portions of the waves indicating the energy transmitted through the control device.

Instead of withdrawing energy from the antenna by the control device, it may be directly transmitted to the antenna from the high frequency source through the control devices, as shown in figure 6. In this figure the high frequency alternator 20 is connected with the primary of the transformer 38, the secondary of which is connected by conductors 39, 40, to the anodes 3, 4 of the arc control device. The cathode 2 is connected by a conductor 41 in series with the primary of a transformer 42 to a point of intermediate potential of the transformer 38. The other connections of the control device are similar to those already described. When a variable potential is impressed on the grid 9 by the telephone 30, variable portions of the wave impulses from the high frequency supply are transmitted by the arcs and impressed as rectified current impulses on the transformer 42, the secondary of which is included in series with the antenna 43. A high frequency current having double the frequency of the source 20 is generated in the antenna, varying in accordance with the variations of the signaling current.

It would be of interest to know whether this device operates without distortion. It is not quite clear that it will give as effective modulation as the 3-electrode vacuum tube.

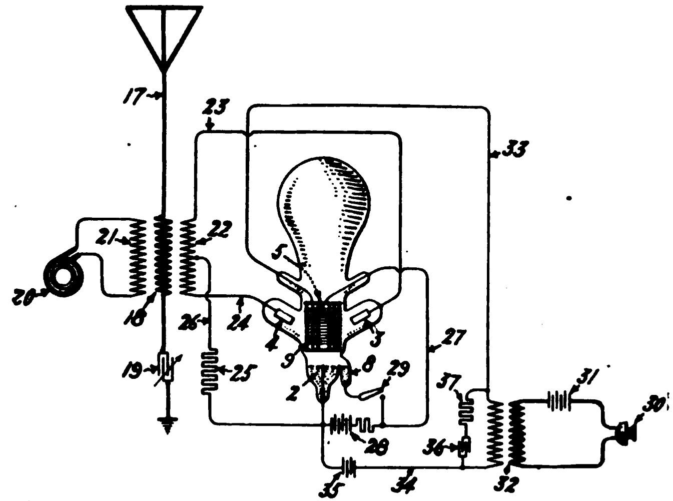


Figure 5—Wireless telephone circuit in which energy is withdrawn from the antenna at speech frequencies

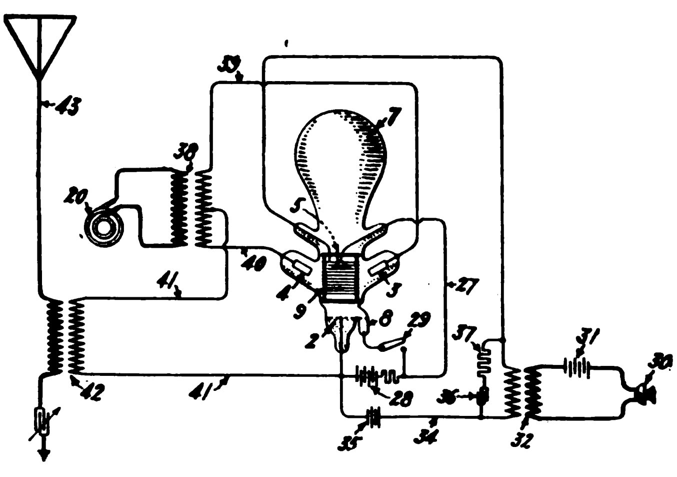


Figure 6—Circuit for wireless telephony in which modulated currents are supplied to the antenna from the radio frequency alternator

Receiving Antenna

THE accompanying diagrams illustrate a specially constructed aerial designed to block out waves or disturbances of a frequency differing from the one which it is desired to receive. The antenna construction is the joint invention of Roy A. Weagant and Harry Shoemaker. They have observed in the average case that resonance adjustments of the receiving aerial are well defined for any particular frequency being received, yet oscillations of other frequencies emanating from near-by powerful transmitters may set the receiving antenna into oscillation at its own frequency, causing a powerful interference. By utilizing the special antenna having loading inductances inserted as shown in figures 1 and 2, undesired frequencies have been eliminated in the manner now to be described.

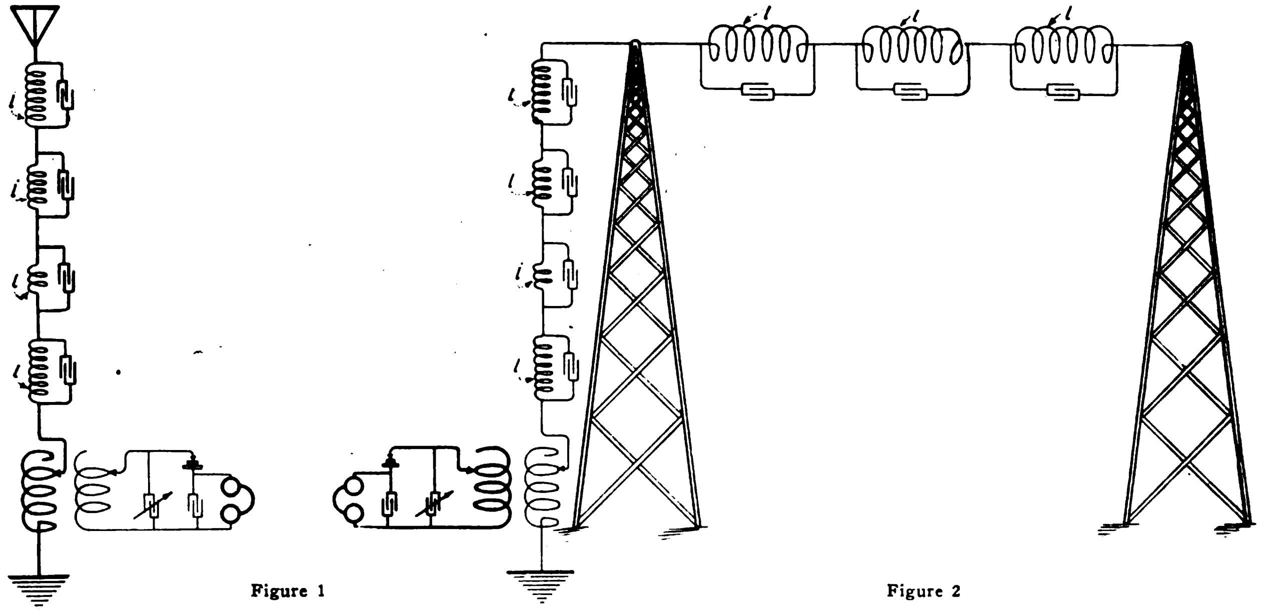


Figure 1

Figure 2

Diagrams illustrating a specially constructed aerial designed to eliminate oscillations of undesired frequencies

It will be noted in these figures that loading inductances i of various values are inserted in the antenna at regular or irregular intervals. These coils are shunted by fixed condensers giving a plurality of oscillation circuits of different frequencies. By this means, the characteristic of the antenna is changed from a condition of substantial uniformly distributed capacity and inductance to a condition of non-uniform distribution.

Such an arrangement of inductance with a capacity in parallel, connected in series in an antenna circuit, has a very high impedance to electrical oscillations with a time period which is the product of the localized inductance and capacity. If the resistance of these lumped circuits was zero, their impedance would be infinite; but by keeping the resistance small, the impedance will be sufficiently large to effectively block out interfering frequencies.

It is preferable that the natural period of any of these lumped circuits be short in comparison to the wave lengths which it is desired to receive. For example, when receiving a wave of 12,000 meters, it is undesirable to use any inserted lumped circuit having a natural period greater than 5,000 meters.

While the insertion of these lumped circuits in the antenna circuit has the effect of blocking out higher frequencies, the entire antenna system must be so designed that its natural frequency will permit resonance at the wave length it is desired to receive.

The Design of 60-Cycle Transformers for Amateur Transmitters

By John J. Holahan

THE fundamental equation of the transformer is

$$E = 4.44 \times \phi \times n \times f \times 10^{-8}$$

Where, E = voltage

ϕ = maximum flux threading the coil at no load and equals the density in lines of force per square inch, B, multiplied by the area of the core A.

n = number of turns in the winding

f = frequency of applied E.M.F.

For the primary E.M.F.

$$E = 4.44 \times \phi_1 \times N_1 \times f \times 10^{-8}$$

For the secondary E.M.F.

$$E_2 = 4.44 \times \phi_2 \times N_2 \times f \times 10^{-8}$$

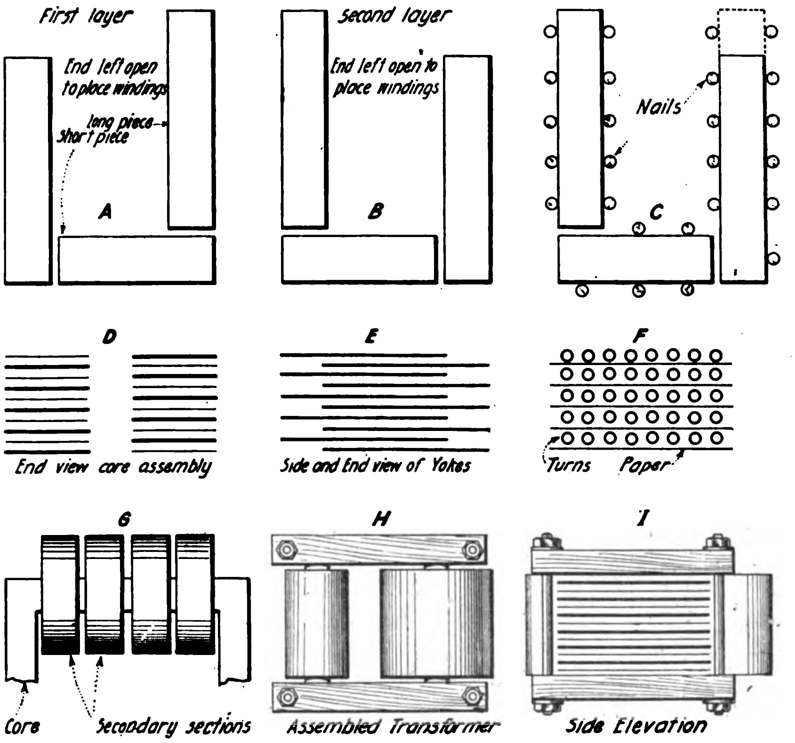
The ratio of primary E.M.F. to the secondary E.M.F. is,

$$\frac{E_2}{E_1} = \frac{4.44\,\phi_2\,N_2\,f\,10^{-8}}{4.44\,\phi_1\,N_1\,f\,10^{-8}} = \frac{\phi_2\,N_2}{\phi_1\,N_1}$$

If $\phi_2 = \phi_1$, that is, if there is no magnetic leakage so that all of the flux produced by the primary cuts the secondary, this becomes,

$$\frac{E_2}{E_1} = \frac{N_2}{N_1}$$

This is the ratio of the secondary E.M.F. to the primary E.M.F. and is equal to the ratio of the number of turns on the two coils. The relation does not hold for open core transformers as they have a large magnetic leakage.



Detailed design of the 60 cycle transformer for amateur transmitters

No Load Losses

The losses at no load are practically those due to hysteresis and eddy currents in the iron core.

The hysteresis loss is $W = K\,B^{1.6}\,f\,\overline{W}$

The eddy current loss is $W = K_2 B^2 f^2 t^2 \overline{W}$

Where, K = hysteresis constant[2] and varies with the grade of iron.

= $.0027 \times 10^{-7}$ for alloyed iron

= $.0615 \times 10^{-7}$ for ordinary iron

K_2 = a constant inversely proportional to the electrical resistance of the iron

= 2.29×10^{-11} for ordinary iron

= $.792 \times 10^{-11}$ for alloyed iron

B = maximum flux density in iron in lines per square inch

f = frequency cycles per second

t = thickness of laminations in inches

$\underline{W}$ = weight of iron in pounds

Iron .014" thick is suitable for transformers. At 60 cycles alloyed iron is preferable to ordinary iron.

Losses Under Load

The losses when the secondary is connected to a load are those due to the resistance of the current in the primary winding, which equals $I_1^2\,R_1$

Where, I_1 = current

R_1 = resistance of the primary winding

The resistance and current in the secondary winding is equal to $I_2^2\,R_2$, where I_2 = current and R_2 = resistance of the secondary winding. Added to this are the iron losses.

The I^2R losses are known as the copper losses and vary with the load. The iron losses are practically constant at all loads. The total losses are simply the addition of the foregoing losses, viz.:

$$\text{Iron loss} + I_1^2\,R_1 + I_2^2\,R_2$$

Efficiency of Transformation

The efficiency

$$= \frac{\text{output}}{\text{input}} \text{ or}$$

$$\text{output} \div (\text{input} + \text{iron losses} + I_1^2R_1 + I_2^2R_2)$$

The efficiency of a transformer is maximum when the iron losses equal the copper losses.

A study of the fundamental formula shows that the number of turns of wire does not depend on the kw. rating of the transformer nor on the current the transformer will draw, but depends solely on the E.M.F., flux and frequency. The only effect the load rating has is to fix the size of wire. The size of wire should be from 1,000 to 2,500 cir. mils per ampere for ½ kw. and about 500 cir. mils per ampere in 10 kw. sizes or larger. To illustrate the point let us change

$$E = 4.44\ A\ B\ n\ f\ 10^{-8} \text{ to}$$

$$An = \frac{E \times 10^8}{4.44\ B\ f}$$

Substituting $E = 110$, $B = 60{,}000$, $f = 60$, we have

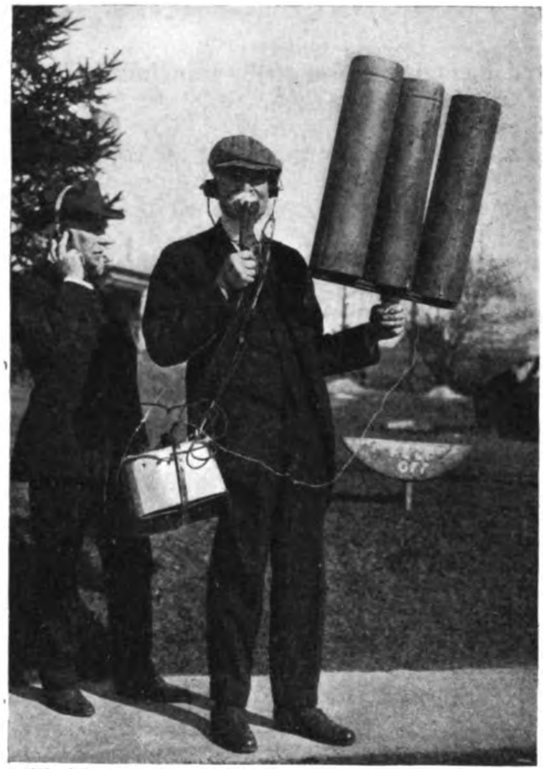
$$An = \frac{110 \times 10^8}{4.44 \times 60{,}000 \times 60} = 688$$

Now if $A = 1$, n should equal 688

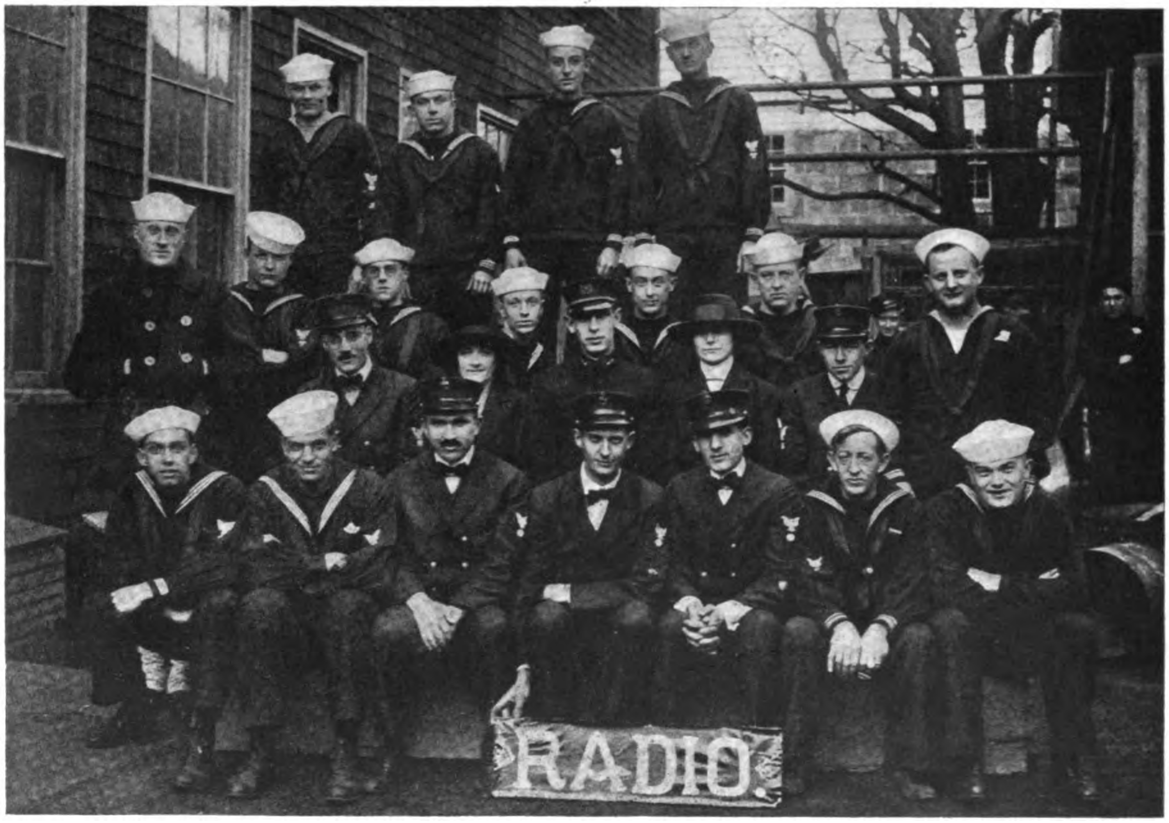
(*Continued on page 22*)

Personalities

Lieut. Walter W. Massie, an old-timer in wireless, who commanded the crew of radio installers of Newport shown in the photo below



W. W. MacFarlane of Philadelphia with his radiophone that establishes fifty-yard communication by stovepipe aerial



Quite a number of ex-amateurs are to be seen in this group, credited with the radio installations on practically all the ships attached to the Second Naval District. Top row, left to right: Johnson, Pelletier, Gallinagh, Sumption. Second row, standing: Newcomb, Whittaker, Lester, Stewart, Wood, Martin, Litchman. Third row, sitting: Bowen, Miss Cavanagh, Clayton, Miss Pfannenmeller, Mair. Bottom row: Sweet, Vaughan, Carter, Crocker, Manuel, Downie and Riccius

My Experiences in the War

Third Instalment of the Personal Narrative of a Pioneer in Aircraft Wireless Who Was Wounded and Captured in the Attempt to Stop the Hun Invasion

By Captain Gordon Adams
South Lancashire Regiment

(*Continued from the April Issue*)

As I lay sprawled out and helpless in the farm field, I peered through the dark. All around were other wounded, and many dead. The wounded numbered about 300, and as it was impossible for our stretcher bearers to take us away, we were left where we lay. There was a man who stayed with me for some considerable time regardless of the hail of bullets and rain of shells. I have often wished that I could find out his name. He refused to leave me, and only at last consented to go when I gave him a military order to rejoin the regiment and carry on with the retirement.

The first agony of my shattered leg was frightful. Then, when the pain had subsided to a certain extent, my chief sensation was one of raging thirst. I attempted to get my water bottle, but it was attached to my belt and I was lying on top of it, and every movement caused me excruciating pain. After a long time, however, I was successful. But I was not to have my drink. The cork was jammed. I pulled and tugged without result, and then began further struggles in an attempt to draw my sword, with which I proposed to attack the refractory cork. I was finally successful; after many futile attempts I managed to extract the cork. Then—how painful is the memory—my hand slipped and I upset the water bottle, spilling the whole of its contents!

After I had been lying there among the turnips for an hour or so the German hordes started advancing upon the position we had just evacuated. I have never heard anything more impressive. Had I known then what I know now about the Hun I doubt if I should have looked at it in the same light, but at that time we thought the Germans an honorable enemy.

The night was gorgeous; no wind and the stars brilliant. After the recent din the deathly silence was all the more marked. Suddenly, far away in the distance, I heard the faint notes of a long trumpet call. This was taken up by others like an echo; nearer and nearer came the notes; they passed, receded into the distance, and finally died away. Then a moment of dead silence, followed by the distant sound of thousands of men singing in beautiful harmony some very majestic battle song. The music swelled to thrilling intensity as nearer and nearer they came; finally, with a triumphant pæan of song the advancing Germans reached their goal. The horde had swept on.

Later in the night I had fits of delirium from which I would recover to find myself chatting merrily with a neighboring turnip. Only one man came near me during the night, and he was one of our own men who was struggling into Solesmes with 13 shrapnel bullets in him. Later I met another man who had exactly 13 bullets in him; but in his case the German soldier who picked him up, thinking it unfortunate for a man to have an unlucky number of honorable wounds, added one more to the total by pushing his bayonet through his face.

About 6 o'clock the next morning the Germans continued their advance; as a preliminary measure, however, they deliberately shot all the British wounded they could find. Out of those left with me on the top of that hill only twelve were spared. My escape was a most fortunate one. The first act of the German who found me was to pull my revolver out of its holster, point it at my face and pull the trigger. Fortunately for me it was not loaded. Just at this moment I looked round and saw a Hun officer approaching me, revolver in hand, ready to finish me off. Luckily, just before he reached me, the order came from their commanding officer to continue the advance. Otherwise, I should never have escaped the brutal end arranged for my gallant comrades.

After this I remained lying where I was. Several small parties of Germans visited me. I was greatly amused at one very juvenile Hun officer who came up, and on searching my haversack discovered my field service note book. The German did not know a word of English, but he could see that this note book contained carefully written out operation orders. He beamed all over his face, imagining no doubt that the finding of such valuable information would get him promotion. I have often wondered what happened afterwards, when it was discovered that the note book was a very old one and the orders it contained were written during Irish command manœuvres three years before.

At length a German doctor arrived and I was taken on a stretcher down to a convent in Solesmes which had been converted into a hospital. They let me lay there without attention for two or three hours. Finally, two savage Boche doctors came and proceeded to set my leg without any anaesthetic. Their method was positively inhuman. One sat on my chest while the other one hauled the leg into position and put rough splints on. In the bed next to me was a French soldier who had been hit in the knee by a shell. His leg from the knee down was only attached to the remainder of the leg by a small strip of flesh. For four days he received no attention, and by that time the lower part of the leg had started to decay. The venom of the Hun medicos passed all understanding. Yet the game spirit of the Allied soldiers was unquenchable. In the room with me were men of my own regiment, Frenchmen and Germans. Suffering as they were, though, I recall how vastly delighted was everyone when a French soldier, who apparently had not shaved for some weeks, just before his departure for some other hospital, came over to my bed and kissed me warmly on both cheeks.

I spent some time at Solesmes, and just when my thigh bone was commencing to mend orders were given that I should be moved back to Valenciennes. The only vehicle available was a small two-wheeled cart. I was put into this on a stretcher but, as luck would have it, after traversing some four miles, the horse fell down and broke my leg again. On arrival in Valenciennes the splints were removed and I was left for the night. That was the worst night I have ever spent. The muscles of the leg set up violent contractive spasms, which drove the splinters of bone inside the leg into the various nerves, adjacent to them. The pain was beyond comprehension; I thought I should never survive it. But I had more to learn of German methods. The leg was not reset until I had been at Valenciennes a week!

The hospital where we were quartered had been a girls' school and owing to the shortage of German nurses the mistress of the school had been roped in and made to do the necessary nursing. No words of mine can ever express my gratitude to those good French ladies of Valenciennes. They wore themselves to shadows, working for the English and French wounded. The old lady who looked after me had nearly been killed in the Franco-Prussian war of 1870. She was then a small girl and was sitting on her father's shoulder when he was shot by the Prussians. Her hatred of Germany and everything German was positively venomous. She was the professor of Psychology and Literature at the School and we used to have great psychological discussions together.

Masses of men, trained and highly disciplined, made the Hun army a vastly impressive machine. This view of a telegraphic headquarters gives an insight into the well organized methods within their lines

There was one particularly unusual thing which came under my observation in that hospital. I had often been told that many Orientals can die simply through an effort of will, but had never believed it until I actually saw it happen at Valenciennes. A Gurkha was brought in, wounded in the calf of the leg. Fearing that the Germans might amputate it, which is contrary to their religion, he calmly stated that he was going to die. There was no earthly reason why he should, but he did. It took him 36 hours to accomplish his end.

It was the custom to move all wounded prisoners back into Germany itself as soon as—and very often before—they were fit to be moved. In due course my turn came. I was taken to the station on a stretcher in company with several others and put into a train which was to convey us to Cologne. The senior of the French ladies who had been nursing us was allowed to come into the station to see us off. As she was handing me in some sandwiches for the journey a German medical officer doctor saw her, and for no greater offence than that of giving food to a "damned Englander" he clenched his fist and knocked her down. Not content with that, he assembled a party of soldiers who fixed their bayonets and hustled her out of the station. You may imagine how our blood boiled.

Arrived at Cologne, we were taken straight to a hospital where I found the second in command of one of our infantry regiments. He had been wounded on the same day that I had been. His instructions had been to hold a position and "never to retire," consequently although only about four of his men survived he stuck to his post though very seriously wounded himself and was subsequently taken prisoner.

Revolting is a mild term to describe the food at Cologne; in quantity it was just sufficient to keep body and soul together. And the medical manhandling was in equal evidence. During the whole time I was there a Turk derived a great deal of daily pleasure in what he pretended was a massage to my leg, his object being to inflict as much pain and do as little good as possible. Everything conceivable was done to make our lives as unpleasant as possible. For one thing, we were allowed no knives or forks to eat with, a deprivation irritating to us, but possibly meaningless to the German himself, who makes as little use of these implements as he possibly can, preferring to use his fingers. Another thing that irritated me was that shaving was forbidden.

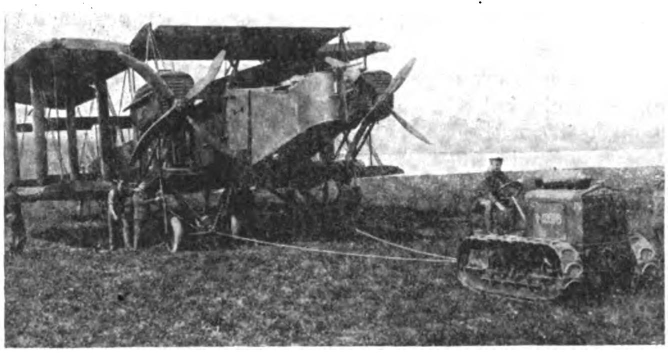
I might mention here, that just before my arrival at this hospital one of the prisoners had lost his way in the building and accidentally got into a passage which the prisoners were forbidden to use. A sentry who he there encountered did not trouble to explain to him his error, but shot him instead. No attempt was made to reconcile the language difficulties, which were considerable, in learning the hospital regulations. It apparently gave little concern to the captors that small infractions might be expected of a most cosmopolitan collection of men, including English, French, Belgians, Turks, Arabs, Senegalese, Sikhs, Gurkhas, and others.

From Cologne I was taken to a prison camp at Osnabruck. Snow was falling when I arrived. Notwithstanding the cold I was put, along with four others, into a stone cellar and kept there for seven days. During that time the cold was intense but we were given fuel sufficient only to last us for three hours altogether. Our beds consisted of three planks and a sack of straw; these we had to burn in order to get a little warmth. After the week had elapsed we were put into other rooms where conditions were only slightly better. The English were always selected for the worst treatment. In order to annoy us, orders were issued that all the English were to be kept apart from each other. The sanitary conditions were filthy. We were allowed a bath but once a fortnight, and that was given grudgingly.

At length, on a certain afternoon I was told by a German *unter offizier* that I was going to be exchanged because they considered me totally incapacitated for further military service. I was taken down into the town of Osnabruck and there at a hospital I met the rest of the English prisoners who were about to be exchanged. We had dinner at this hospital and the Germans told us we could have anything we liked. There was a certain amount of grim humor in their imagining that by one hour of good treatment they could wipe out the memory of months of ill-usage. But then, in any question of psychology the German is the most perfect ass.

Clean, cheerful quarters and a staff of sympathetic attendants are the rule in American hospitals, where wounded soldiers are instructed in useful vocations, by contrast with the German idea which Capt. Adams describes

At 9 in the evening we were put on board what they were pleased to term a hospital train. It consisted merely of cattle trucks and into these were put the wrecks of humanity whom the Germans were liberating. I have never seen such a disgraceful sight in my life as presented by those English soldiers. A large proportion were blind, and practically all the remainder were deficient of legs and arms. The whole lot were filthy and absolutely in rags. It took us 14 hours to get to Flushing and then we saw the Germans for whom we were being exchanged. They all looked well fed; and they were clean and well clothed.



This British official photograph shows a tractor bringing a huge Royal Air Force bomber into position, illustrating the magnitude of the problems of the author, who compiled technical data for all types of machines

After a very rough crossing we landed at Folkestone and went straight up to London, where I was sent to a hospital to undergo a small operation. I shall never forget what luxury a fire and the clean sheets seemed to me.

After this I had to wait for months to get sufficiently fit for the big operation. The bone of my leg had healed up crooked, the result being a shortening of 4½ inches. The operation, which was performed in the autumn of 1915, consisted in opening the leg, sawing the bones apart, putting them into their proper places and then screwing steel plates down the side. As a testimonial to Hun savageness, for the rest of my life I shall carry about with me 16 inches of steel plating and 24 screws.

During the time I was in the hospital recovering from this operation I met another exchanged prisoner who had been shot in the arm. The Germans cut the entire arm off, leaving no stump to which could have been attached an artificial one. Shortly afterwards, when he was being moved by train from one prison to another, he asked a sentry for a glass of water. The sentry replied by sticking his bayonet through the other arm. The German doctors then removed that also, leaving in this case, as in the former, not a vestige of a stump.

It was eight months after my operation before I was fit to do even an office job; but finally, after worrying medical boards, I was taken on as head of one of the sections of the design branch in the Air Ministry. My work consisted of compiling all technical data about different types of machines and their performances when undergoing official tests. I also had to interview all inventors of new types of machines. Most of them were extraordinarily funny. One bright individual claimed that he had invented a machine which would fly for thousands and thousands of miles at a speed of 300 miles an hour without any engine power at all. He had to have an engine to get up flying speed to start with but then he claimed that further power was unnecessary, as the wind pressure would push the propeller round.

Another man had spent nine years in trying to produce a machine of the ornithopter or wing-flapping type. For experimental purposes he had rigged up in his garden a large iron frame work to which were attached the wings that flapped. The flapping power was supplied by one or more of his numerous small children who were put on in turn to wind a handle which operated the mechanism. He wished to demonstrate that by flapping the wings the whole contrivance could be made to leave the ground. It certainly did jump about 6 inches off the earth, but it did so at the moment when the wings were at the top point of each flap, when aerodynamically the machine should have been resting most firmly on the ground. The explanation was that the whole affair was jerked upwards by the inertia of upward-moving wings.

Still another budding inventor was responsible for the following bright idea: In order that fast scout machines of small gasoline carrying capacity might be enabled to remain in the air for a longer time at a stretch, he suggested that they should be followed by slow machines carrying a large supply of gasoline. When running dry, all that would be required of the pilot of the scout machine would be to fly under the large machine, and, after seizing the end of a long india-rubber pipe which the pilot of the large machine would hang overboard, deftly insert it into his own tank. Then by a manipulation of cunningly devised tap he would be enabled to replenish his tank and go on his way rejoicing. Although the inventor was suitably thanked for placing at the disposal of the Air Board his exceedingly original scheme, the idea was not acted upon as the authorities did not deem it advisable to include in the syllabus of a pilot's training instruction the art of the milkmaid.

From the Air Ministry I was appointed instructor in theory and construction at the Central Flying School. My work there was varied and interesting. On arrival I was told to reorganize the whole system of training of engine men, fitters and riggers. It entailed a tremendous amount of work, but finally I got it straightened out. My system was as follows: Each class, consisting of about 200 fitters and 200 riggers, went through the course in about 9 weeks. About the first half of this time the fitters were given instruction of a more or less general nature on each of the different types of engine which I kept in the instruction shops. The remainder of the time was devoted to specialized instruction on one particular engine. In selecting the men for their specialist course I endeavored as far as possible to allot each man to the particular type of engine which interested him most, in addition to which each man completed a short course of instruction on the simple repairs which could be done on a workshop lorry. I also endeavored to send each man for a short time to one of the flying squadrons to get practical experience of squadron work.

A remarkable picture of a group of all the American "Aces" in France, taken in France during the days of fighting, just before the armistice was signed

The training for riggers was run along similar lines, with the exception that in place of the repair work on the workshop lorries I gave them instruction in splicing and sail-making.

Each man during his course received about 400 hours instruction. I endeavored, whenever possible, by arrangement with squadron commanders and the officer in charge of workshops, to give the men repairs to do which would actually be used on machines in the air. I found that it stimulated their interest considerably if they knew that some real use would be made of their work.

Apart from training mechanics I was also responsible for all the ground instruction to officer pupils. I had under me instructors in wireless, bombing, artillery observation, photography, gunnery and reconnaissance, who carried out instructions in these special departments. The theory of flight and construction of machines I dealt with myself. At one time I started to organize a wireless flight which I considered would facilitate the instruction of wireless and artillery observation. It did not last long, however, as Training Brigade H. Q. said that although this idea was excellent the necessary machines could not at that moment be spared. My perfectly good wireless flight therefore came to a sudden end.

From the Central Flying School I returned to the Air Ministry and joined the department which dealt with the design of armament, compasses and bomb sights. I had charge of designs of bomb sights and bomb carriers, and in addition I again had to interview inventors and receive their ideas and suggestions. It was to this department that the famous and historic woodpecker scheme was submitted.

In all seriousness a certain man forwarded a suggestion for training thousands of woodpeckers to fly to Germany and on arrival to get busy with their beaks and pick out the mortar from between the bricks in Krupp's gun factory so that eventually the whole building would crash to the ground.

Leaving the Air Ministry again, I took over command of and organized a new type of supply depot. This depot I found to be in a very unsatisfactory state. It was the property of one aircraft manufacturing company and was used by four others. The mechanics were entirely civilian. Its inefficiency was due to three causes: (1) lack of military control; (2) lack of co-ordination between the R. F. C. and the firms supplying the machines; (3) difficulty in obtaining pilots to take new machines to their destinations.

With the new organization I had under me a staff of expert technical R. F. C. officers and mechanics. Machines arrived from the makers in parts and were immediately turned over to the riggers for assembly. That completed to the satisfaction of the inspecting officers, they passed into the hands of the engine men, who tuned up the engine. After that they passed through various other departments for gun testing, instrument adjusting, and so on. When finally ready for flight they were handed over to the despatch officer. His duty was to know the exact position of each machine, find out in advance to what squadron it was allotted, and then have it tested and delivered at its destination. For this purpose he had under him a staff of twenty pilots. From start to finish each machine went through eleven different processes. Owing to the extremely urgent need for machines at the front all ranks had to work at least 12 hours a day.

I succeeded in a very short time in trebling the output, but I had hopelessly overworked myself and finally, after carrying on as long as possible, my leg troubled me to such an extent that I had to go on leave and was invalided out of the service on April 23, 1918.

The Design of 60-Cycle Transformers for Amateur Transmitters

(*Continued from page* 17)

and if $A = 688$, n should equal 1
if $A = 2$, n should equal 344
and if $A = 344$, n should equal 2, etc.

Any value can be chosen for A or n provided $An = 688$.

NUMBER OF TURNS

The number of turns can be determined approximately as follows:

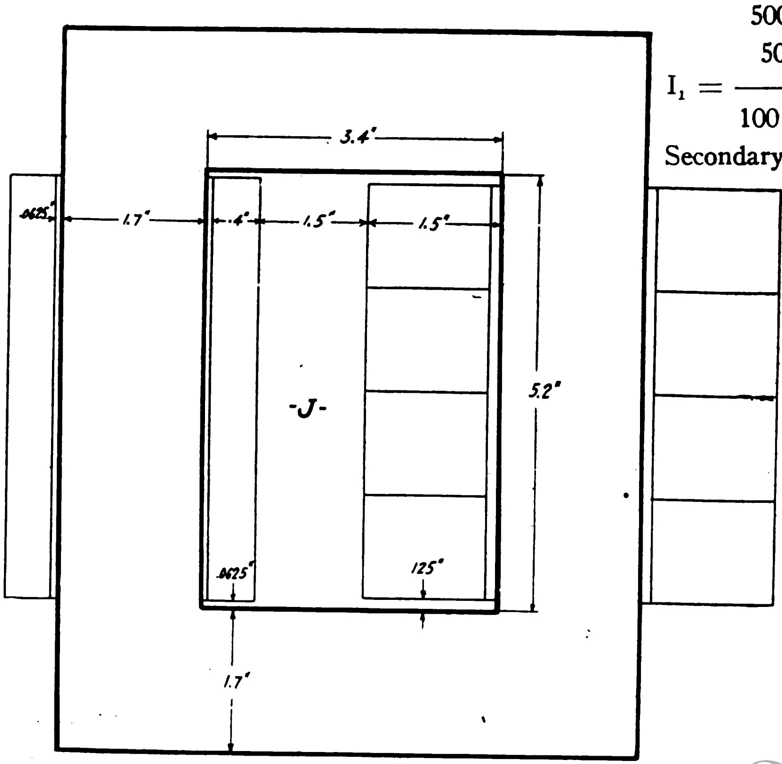
$$n_1 = \frac{E}{K\sqrt{W}}$$

Where E = coil voltage
W = watts capacity of the transformer
$K = .021$ for small 60 cycle transformers and $K = .03$ for larger transformers.

If the formula above is used to find the primary turns, the secondary turns equal

$$n_2 = \frac{E_2 n_1}{E_1}$$

In transformers for radio work, the current should be determined from the kilovolt-ampere rating rather than from the kw, rating as the power factor (cos ϕ) is rather low.



General plan with dimensions of the core, primary and secondary coils

EXAMPLE

Let $W = 500$ watts
$E_1 = 110$ volts (primary)
$f = 60$ cycles
$E_2 = 13{,}500$ volts (secondary)
Power factor $= .8$ (assumed) $= \cos\phi$

The power $W = E_1 I_1 \cos\phi$. Substituting the above values,

$$500 = 110 \times I_1 \times .8$$

$$I_1 = \frac{500}{100 \times .8} = 5 \text{ amperes (approx.)}$$

Secondary current

$$I_2 = \frac{E_1 I_1}{E_2} = \frac{110 \times 5}{13{,}500} =$$

.04 ampere approx.

The area of the primary wire, allowing 1000 cir. mils per ampere $= 5 \times 1000 = 5000$ cir. mils. From a wire table we find that the wire nearest to this is No. 13 DCC wire. Its resistance is 2 ohms per 1000 feet. For the secondary, the area $= .04 \times 2500 = 100$ cir. mils and from

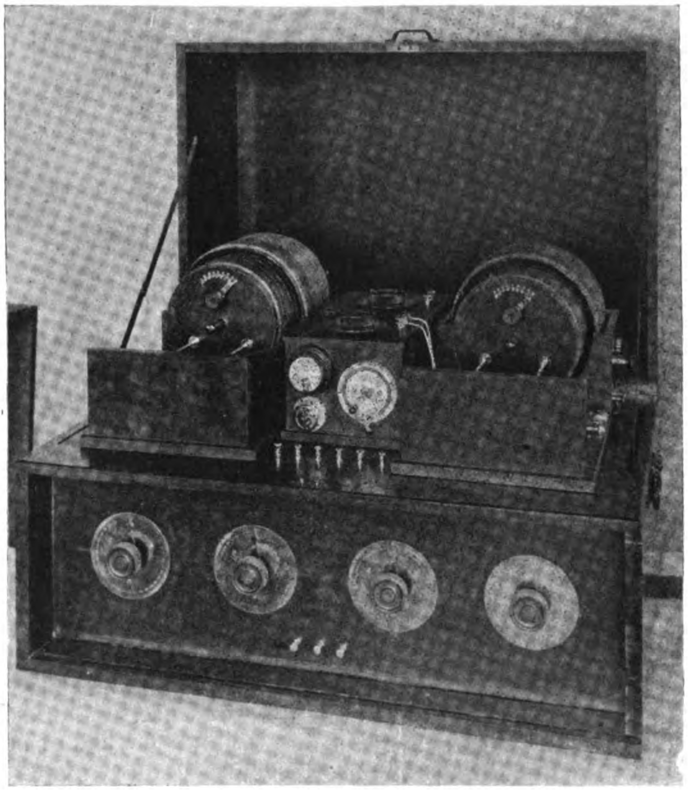
(*Continued on page* 26)

Simultaneous Sending and Receiving

A Wireless System for Duplex Operation and the Prevention of Interference

The paper read by E. F. W. Alexanderson at the April meeting of the Institute of Radio Engineers

An Abstract by E. E. Bucher,
Director of Instruction, Marconi Institute



Radio receiving set with barrage attachment invented by E. F. W. Alexanderson

OUTLINING an extensive series of experiments conducted mainly at the Marconi Company's high power station at New Brunswick, N. J., Mr. Alexanderson interestingly described three recent lines of radio development. Explaining how, with a duplex system for radio telephony, a land line telephone subscriber at any point in the city may pick up a local telephone and speak by radio through the wireless telephone transmitting station and receive a reply as in every-day wire telephony, the speaker gave details of what he terms the "bridge receiver" and the "barrage receiver."

The bridge receiver is a device which permits reception of signals at a given station while the local transmitter is in operation, with little or no interference. In this system, separate transmitting and receiving antennae are used, but they are erected close enough so that the receiver and transmitter may be considered to be in paired branches of a Wheatstone bridge.

The barrage receiver is a combination of two aperiodic horizontal antennae, which are said to have distinctly unilateral directional characteristics. By means of appropriate phase shifting devices, signals from any given direction can be balanced out while the desired signal is retained.

Regarding the system of duplex radio telephony, Mr. Alexanderson made public the diagram in figure 1, in which the left hand part of the drawing shows a radio frequency alternator N in series with the antenna system shunted by the well-known magnetic amplifier M for control of its output. The right hand part of the drawing shows a receiving antenna which is separated from the sending antenna at a satisfactory distance so that the selectivity of ordinary receivers and transmitters can be depended upon for differentiation between the wave lengths of the sending and receiving stations. Each pair of sending and receiving stations is connected together by a wire line and to the exchange of a local telephone system, so that the land line telephone subscriber may be connected to the radio station.

In the diagram, the lines from the sending and receiving stations are introduced in series with the subscriber's line. These circuits involve certain novelties of operation which the speaker explained. For example, a telephone current originating in the wireless receiving station from a distant transmitter sets up currents flowing between the telephone subscriber's instrument and the radio transmitting station. The telephone current originating from the subscriber's instrument takes the same path. This brings about the interesting condition that the currents originating in the receiving station will be re-transmitted by the sending station. As a consequence, both sides of the conversation are transmitted by each sending station and a third party may hear both speakers by tuning in on either of the two transmitted wave lengths.

In order to prevent self-exciting oscillations which may result from amplification of the local receiver currents by the proximity of the transmitter, it is necessary that the amplification of the receiver be held within a certain critical value; for if telephone currents are set up in the subscriber's line of greater intensities than the currents originally produced by the speaker, the same current will be relayed again through the sending station and come back to the speaker in an intensified form, and would be again transmitted from the first sending station. The resulting cumulative effect would be similar to that obtained in ordinary wire telephony when the receiver is held close to the transmitter.

SIMULTANEOUS TRANSMISSION AND RECEPTION WITH THE ANTENNAE SUSPENDED FROM THE SAME MAST

Mr. Alexanderson showed a system for duplex radio telephony whereby two antennae were supported from the same mast, interference between them being prevented by inductive and capacitive neutralization. A diagrammatic representation is shown in figure 2, in which A is a radio frequency alternator shunted by the magnetic amplifier M, and T-1 is the microphone transmitter connected in the control circuit of the magnetic amplifier. Antenna A is the transmitting aerial and antenna B is used to create a potential of opposite phase to the potential of the sending antenna. This negative potential is transferred to the receiving antenna through the transformer T and through what is termed an exposure condenser E. The magnitude of this negative potential is adjusted to counterbalance the direct exposure between the antenna A and B, thus leaving the receiving apparatus with the coupling L at ground potential. Since the phase relation of the transformer is not exactly 180° a residual potential is left in the receiving apparatus which may be effectively blocked out by the trap F, comprising an inductance and a capacity in shunt. This gives a very high impedance to the interfering current but allows the incoming signal to pass.

Mr. Alexanderson mentioned certain tests made at Schenectady, when it was possible to receive signals from stations 2,500 miles distant without appreciable interference from a sender giving 20 amperes at 10,000 volts in the antenna A.

He described the system of capacitive neutralization between the transmitting and receiving antenna as shown in figure 3; since this circuit has many of the characteristics of the Wheatstone bridge (as shown diagrammatically in figure 4) it has been termed the "bridge receiver."

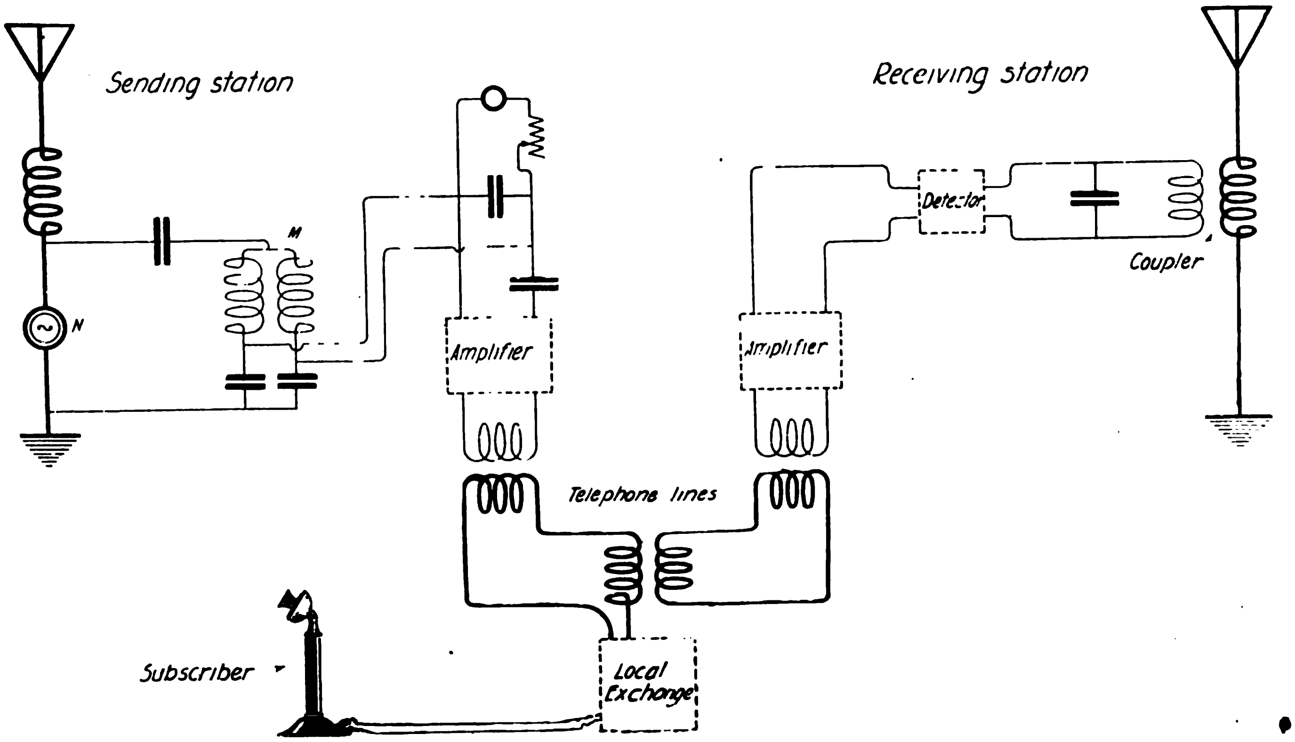


Figure 1—Radio telephone system permitting communication with land-line exchange

In figure 3, the receiving antenna A-2 is connected to the primary loading coil T-2 through the counterpoise condenser C-3. The loading coil is coupled aperiodically to the secondary of the receiving set through a linking circuit. The counterpoise condenser is connected through the exposure condensers C-1 and C-2 to the transmitting antenna. Although this method of neutralization, in large measure, eliminates the interference of the local transmitter, local induction other than that due to the capacity coupling between the antennae gave a residual effect that was eventually taken care of by a device called a phase rotor. The phase rotor feeds currents from the transmitter to the receiver at any desired phase angle; in one branch it consists of an inductance and capacity in series; and in the second branch of an inductance, capacity and resistance in series. By adjusting the position of the rotor L the electromotive

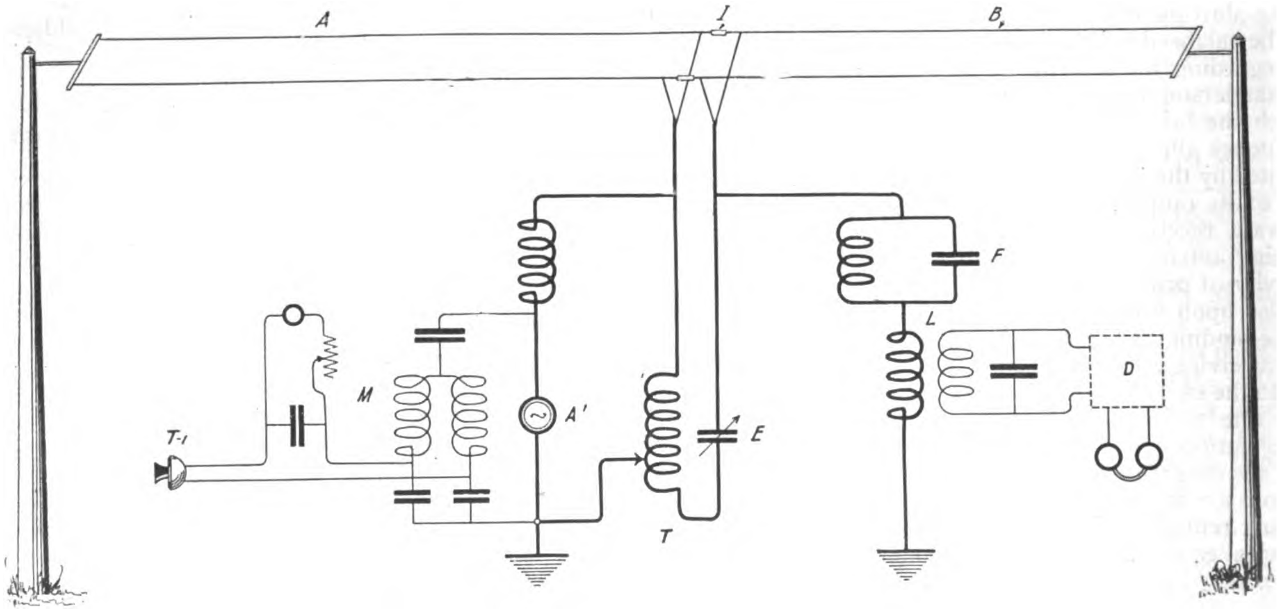


Figure 2—Radio telephone system for simultaneous transmission and reception

force induced in it may be made to assume any desired phase relation to the primary voltage. In other words, the rotor of figure 3 is adjusted to withdraw energy from the antenna circuit of the transmitter, through the coil F-1 and the transformer I, of the proper phase angle to neutralize the local action of the transmitting apparatus upon the secondary circuits of the receiver R.

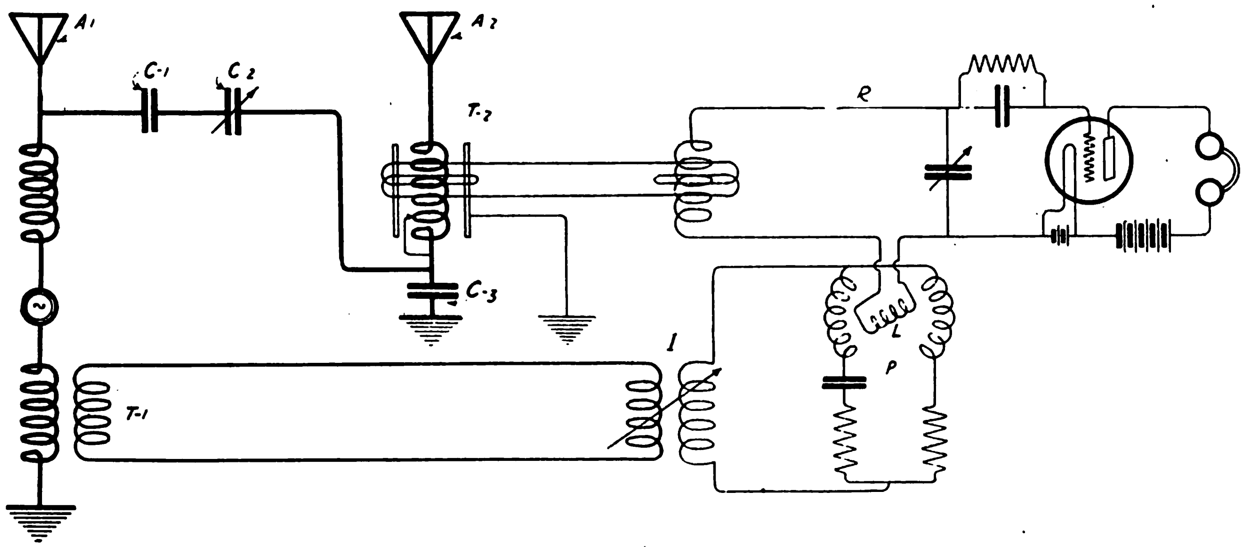


Figure 3—Fundamental circuits of the "Bridge Receiver"

In the equivalent circuit shown in figure 4, the exposure condensers and counterpoise condensers form an artificial circuit duplicating the potential drops between the sending antenna, the receiving antenna and ground. By adjusting the exposure condenser, two equipotential points are found between which the receiving set is connected. The right hand arm of the branch is effectively represented by the dotted lines, the receiving antenna in this diagram having been assumed to be one of the umbrella type.

CONSTRUCTION AND OPERATION OF THE BARRAGE RECEIVER DESCRIBED

The so-called barrage receiver is shown in figure 5. It comprises two horizontal aperiodic antennae which Alexanderson declares should preferably have one-quarter wave length separation for the particular signals being received. In designing the barrage receiver he observed the following principles: In his estimation, the difficulty of balancing two tuned circuits is very great and accordingly the antenna or energy collectors should be aperiodic. Second, the balancing should consist in neutralizing the electromotive forces before they have a chance to create oscillating currents. Third, the two antennae should be of the same characteristic; in other words, it is preferable to balance a magnetic exposure against another magnetic exposure rather than against an electrostatic exposure, as is done in the Bellini-Tosi uni-directional receiver.

This is accomplished in the diagram of figure 5 by two phase rotors which are coupled to the horizontal antenna. The rotors are coupled to a common detector circuit which in this diagram comprises a three electrode vacuum tube. By turning the rotary coil of the phase rotators, signals may be drawn from the antennae at any desired phase angle and thus interference from any direction neutralized.

Mr. Alexanderson states that with this apparatus it was possible to receive signals from San Diego at New Brunswick while the large transmitting station at New Brunswick was in operation. The receiving station in this case was erected about three miles from the New Brunswick transmitter.

Each of the antennae used for this demonstration were two miles in length.

A discussion of the paper followed, in which several previous patents bearing upon the principle of simultaneous transmission and reception were cited. Lester

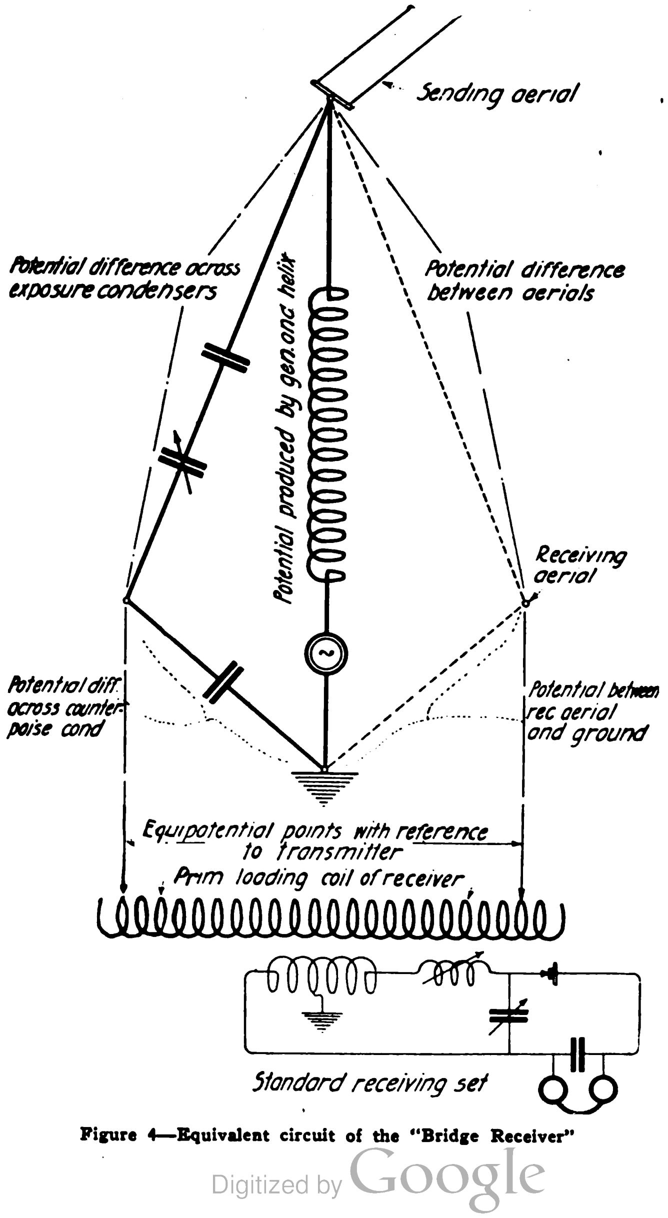

Sending aerial
Potential difference across exposure condensers
Potential produced by gen. and helix
Potential difference between aerials
Receiving aerial
Potential diff. across counterpoise cond
Potential between rec aerial and ground
Equipotential points with reference to transmitter
Prim loading coil of receiver
Standard receiving set

Figure 4—Equivalent circuit of the "Bridge Receiver"

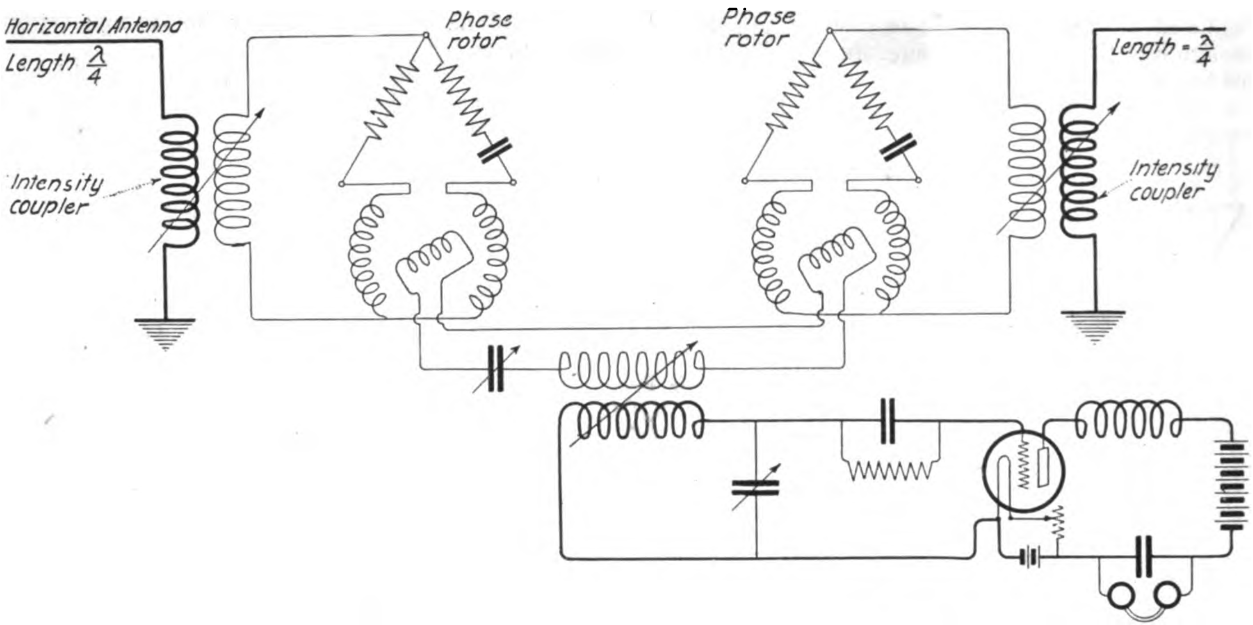


Figure 5—Fundamental circuits of the "Barrage Receiver" with phase rotators for eliminating interference

Israel and Wm. H. Priess described some experiments along that line, conducted by them at the instigation of the U. S. Government. Mr. Priess remarked that a 50 per cent difference in wave length between the transmitter and receiver was necessary to insure a factor of safety.

It was brought out that Alexanderson's duplex system with closely supported antennae, operated more effectively with undamped waves than with damped waves.

The Design of 60-Cycle Transformers for Amateur Transmitters

(Continued from page 22)

a wire table we find that this corresponds to No. 30SSC wire. Its resistance is about 103 ohms per thousand feet.

To obtain the number of turns on the primary

$$n = \frac{E}{.021\sqrt{W}} = \frac{110}{.021\sqrt{500}} = 238 \text{ turns}$$

At 60,000 lines per square inch, A n should = 688, so that

$$A = \frac{688}{n} \text{ or } \frac{688}{238} = 2.89 \text{ sq. in.}$$

For economy of copper, the coil and core should be square in cross section; hence the core should be $\sqrt{2.89} = 1.7''$ on side.

The secondary turns

$$n_2 = \frac{E_2 \times n_1}{E_1} = \frac{13{,}500 \times 238}{110} = 29{,}274 \text{ turns}$$

DETERMINING THE PRIMARY AND SECONDARY DIMENSIONS

The voltage per section of the secondary should not exceed 4000 volts. Dividing 13,500 by 4 gives 3375 volts per coil, and dividing 29,274 by 4 gives 7319 turns per coil of the secondary. If we make each coil of the secondary square in cross section, we have $\sqrt{7319}$ or approximately 85 turns on a side. Allowing for pieces of insulation .05" thick between coils, and .125" micanite between the ends of the coils and the core, gives, allowing 4 mils insulation, 4 (85 × .014") + (3 × .05) + (2 × .125) = 5.2" as the height of the transformer window. (See figure J). Since the diameter of No. 30 D.S.C. wire is .014", the thickness of the secondary coil = (85 × .014") + 0.125 + one layer of tape = 1.5". The factor 0.125 is the thickness of the micanite tube.

Allowing .0625" as the thickness of the micanite tube between the primary coil and core, gives about 5" winding space. Dividing 5 by .078" gives about 64 turns per layer for primary coil. Dividing 64 into 238 gives 3 layers for the primary and calls for 46 additional turns to give the full 238 turns. The thickness of the primary coil is then 4 × .078 + .0625 or 0.4" approximately.

Mean length of secondary turn = 4 (1.7 + 1.4) = 12.5". And

$$\frac{12.5'' \times 29{,}274}{12} = 30{,}494 \text{ ft. total length of secondary wire.}$$

At 103 ohms per thousand, the resistance of the secondary = 30.5 × 103 = 3141 ohms. The copper loss of secondary = $I_2^2 \times R_2$ = 3141 × .04 × .04 = 6.7 or 7 watts.

The mean length of primary turn = 4 (1.7 + .4) = 8.4". This multiplied by 238 = 1999" and divided by 12 gives 166 feet as the length of the primary wire. The total resistance at 2 ohms per thousand = .166 × 2 = .332 ohms. The primary copper loss = I_1^2 R = .332 × 5 × 5 = 8.36 watts. Total copper loss = 8.36 + 7 = 15.36 watts.

The iron loss of good silicon steel is approximately .8 watt per pound. For the highest efficiency, the iron loss must equal the copper loss. Dividing 15.36 by .8 gives 19.2 pounds as the weight of iron in the core. Dividing 19.2 by .278 gives 69.4 as the total volume of the core. The length of the core with corners equals (5.2 + 1.7 + 1.7) = 8.6 inches and for two cores = 2 × 8.6 = 17.2 inches. The total volume of the cores therefore equals 1.7 × 1.7 × 17.2 = 49.7 cubic inches. Subtracting this from the total volume, 69.4 — 49.7 = 19.73 as the volume of the yokes. Dividing this by 2.89 gives 6.8 as the length of both yokes. Dividing this by 2 gives 3.4 inches as the width of the transformer window.

(Continued on page 38)

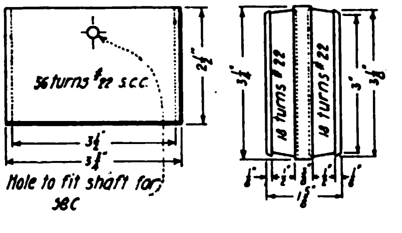
EXPERIMENTERS' WORLD

Views of readers on subjects and specific problems they would like to have discussed in this department will be appreciated by the Editor

My Conception of the Ideal 200 Meter Receiving Set

By Frank V. Bremer

A RECEIVING tuner for amateur wave lengths should have a range of tuning between 180 and 580 meters, and should be fitted with a regenerative coupling. With the set described here, amateur stations as far west as Denver have been copied in New York, a distance of approximately 1900 miles.



Figures 1 and 2—Dimensions of the primary and secondary coils of the receiving tuner

AERIAL

The amateur aerial should consist of from 4 to 8 stranded wires with a horizontal length of from 80 to 100 feet and a vertical height of from 30 to 100 feet, with an approved type of modern lead-in insulator. All connections must be securely soldered.

EARTH PLATE

A good earth plate can be formed by burying square sheets of copper or brass about three feet below the surface under the whole length of the aerial. In addition, the ground lead should be connected to all gas and water pipes available in the building.

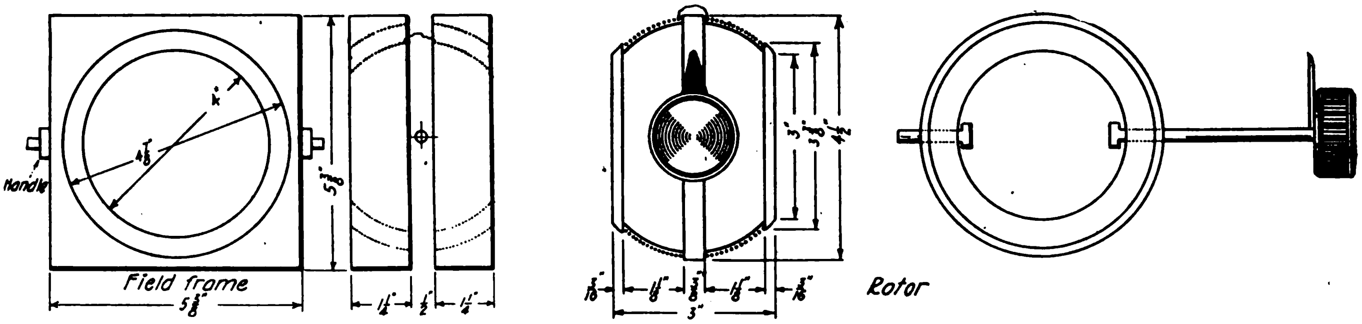


Figure 3—Dimensions of field frames and rotor for the variometer

RECEIVING TUNER

Special care should be taken in the construction of the tuning transformer. The regenerative valve short wave receiver, consisting of two variometers and a coupler which can be mounted together, or separately, constitutes in my mind the most efficient set.

The primary should consist of a cardboard or bakelite tube 2½ inches in length by 3¾ inches in diameter, wound with 56 turns of No. 22 SCC wire with a tap taken from it every eight turns. These should be brought out to a switch. The dimensions are shown in figure 1.

The secondary should consist of a ball turned to the shape of a variometer, 3¾ inches long by 1⅝ inches in diameter, wound with 18 turns of No. 22 SCC wire on each side, or 36 turns in all. Both coils are wound in the same direction and no taps are to be taken off. The inductance is varied by turning the rotating coil. The dimensions are shown in figure 2.

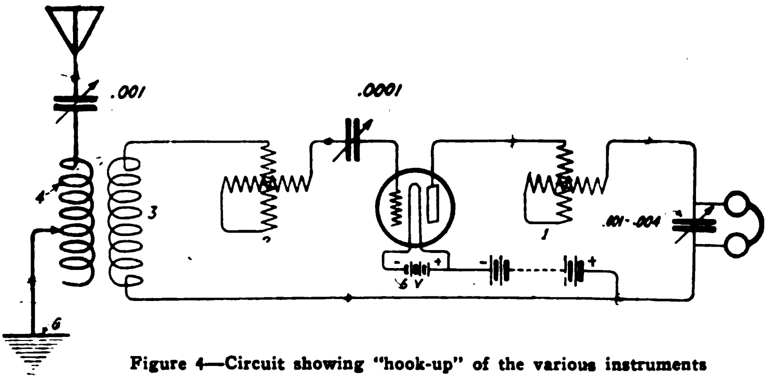


Figure 4—Circuit showing "hook-up" of the various instruments

VARIOMETERS

The variometers are turned from wood and should consist of two field frames and one rotor, sizes as per the drawing, figure 3. Two are required, both of the same size.

The field frames of the variometer for the grid circuit are wound with 30 turns of No. 20 SCC wire, wound clockwise; the rotor is wound with 32 turns No. 20 SCC wire, wound counter clockwise.

The field frames of the variometer for the plate circuit are wound with 25 turns of No. 18 SCC wire, wound clockwise; the rotor has 27 turns of No. 18 SCC wire, wound counter clockwise. The dimensions of the rotors are given in figure 5.

The design of the variometers should be such that they may be rotated throughout 180°. Coil 3 in figure 4 must rotate through 90°. Coil 4, the primary, is stationary.

The field frames are stationary and must be separated ½ inch. The horizontal axes of the variometers must be at least 12 inches apart.

TELEPHONES

For the best results a pair of Baldwin amplifying telephones should be used, but any pair of 2,000 ohm telephones will prove satisfactory.

DETECTOR

It is essential that a good three element valve detector of either the round or tubular type should be used and special attention paid to the voltage adjustments. A storage cell should be used for lighting the filament, as it is important that the current be constant. For the plate circuit, flashlight batteries or a bank of small storage cells may be used. For maximum signals, a single cell adjustment of the plate battery should be provided for.

VARIABLE CONDENSERS

Three variable condensers of the following capacities are required, viz.: one of .001 mfd. for variation of the primary wave length, one of .0001 mfd. for the grid circuit; and one of .001 to .004 mfd. for shunting the telephones.

If these instructions are carefully carried out, a set capable of amplifying 100 times will result. All connections should be thoroughly soldered and the dimensions of the coils and the capacities of the condensers duplicated in detail.

For those who prefer the cabinet type of apparatus, a suggested design is shown in figure 5.

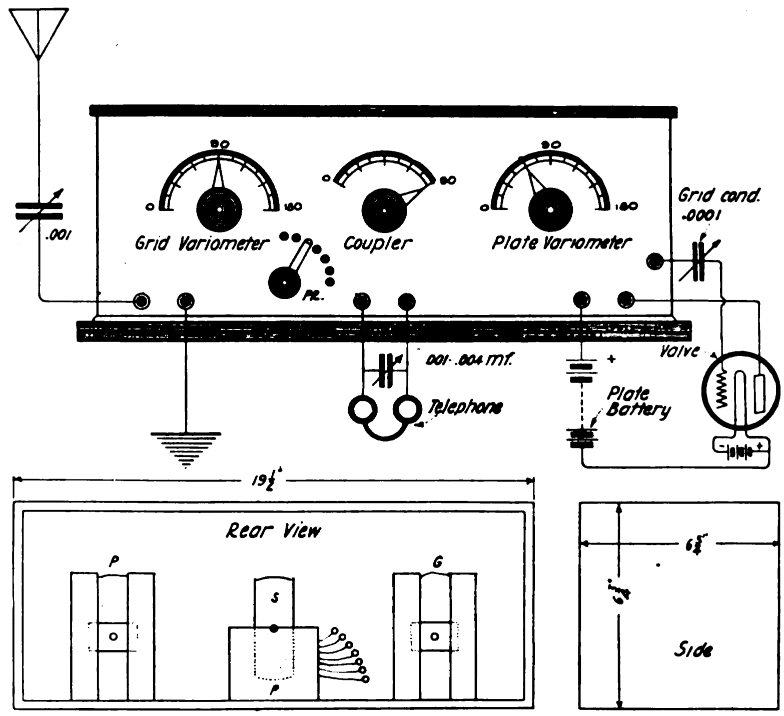


Figure 5—Design of a cabinet set

Useful Experimental Apparatus for the Amateur's Laboratory

By Thos. W. Benson

HOW TO DESIGN A WATER RHEOSTAT

IT is seldom that the experimenter gives a second thought to the proper design of a water rheostat. The usual method is to use as large plates as possible and add salt or acid to the solution until sufficient current flows. Often the water heats badly and boils, resulting in a constantly changing resistance. To the many experimenters who use this convenient and cheap form of resistance the following suggestions are offered to assist them in building a rheostat suitable for the work in hand.

The problem of designing a rheostat is usually a question of the size and kind of plates, the density of the solution and the chemicals at hand. The following method will give accurate results within the range of the usual amateur's requirements.

The maximum current that can be handled by a water rheostat depends chiefly, among other things, on the cubic inches of electrolyte in the container. It would appear that the energy absorbed would be limited by the radiation surface, but calculations on this basis do not agree well with experimental results.

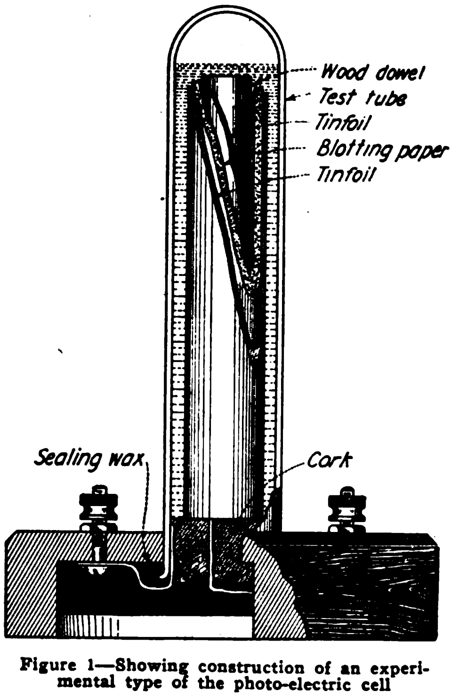


Figure 1—Showing construction of an experimental type of the photo-electric cell

Suppose we have a large porcelain battery jar and wish to construct a rheostat to use with an arc lamp. First determine the cubical contents of the container in the usual manner. The jar used by the writer in an experiment of this kind measured 7 inches inside diameter and 12 inches high. Allowing one inch at the top gives a solution height of 11 inches, or a trifle over 422 cubic inches of solution. When used indoors without special cooling, the rheostat is limited to 2 watts per cubic inch, hence the rating of the rheostat would be 2x422 or 844 watts.

We must decide on the maximum voltage drop desired. Since the rheostat in question was to operate with an arc lamp, 80 volts drop was decided upon, allowing 30 volts minimum across the arc. Dividing the wattage (844) by the voltage drop (80) we find that the current in amperes will be 10.55 or roughly 10 amperes.

The allowable maximum current density for the plates is one ampere per square inch. However, there is plenty of room for the plates, which were cut from 1/16 inch iron, 5 inches in diameter, giving an area of 19.6 square inches. The upper plate was perforated with holes by means of a twenty penny nail and fastened to the adjusting rod by two bolts, one on either side of the plate. The lower plate was left plain, a rubber covered wire being used to make connection to it.

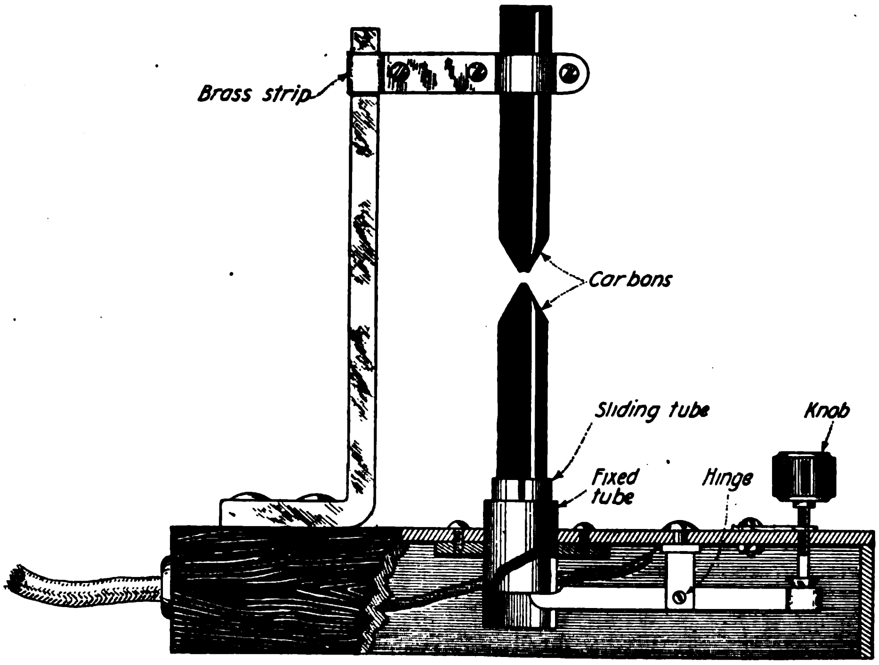


Figure 2—Showing the design of the hand-fed arc light

Now that we have finished the mechanical design of the rheostat, we will determine the proper density of the solution. The chemical is a matter of judgment. We have the choice of sodium sulphate, sodium chloride or copper sulphate with iron plates. Where lead or carbon plates are used sulphuric acid may be employed.

The formula for calculating the density of the solution in per cent is as follows:

$$\% = \frac{DK}{V}$$

Where, D = the maximum distance between plates
V = maximum voltage drop
K = constant obtained from table following

Sulphuric acid—.08
Sodium Chloride—.25
Sodium Sulphate—.45
Copper Sulphate—.90

For the rheostat under consideration copper sulphate was selected because it does not gas or polarize the electrodes. The density from the preceding formula is:

$$\frac{10 \times .9}{80} = \frac{.9}{8} = .1125, \text{ or a little over } 11\% \text{ by weight.}$$

This was found to give the desired result and worked perfectly with the arc without heating to a noticeable extent. A water rheostat for any experimenter's requirements can be designed from these data by bearing in mind the relations the various factors bear to each other. These may be listed as follows:

Energy absorbed depends on cubic inches of electrolyte.

Area of plates depends on current. One ampere per square inch is not to be exceeded.

Voltage drop depends on maximum distance between plates. When this is determined by size of container the density of solution is varied to obtain the proper result.

EXPERIMENTAL PHOTO-ELECTRIC CELLS

Photo-electric phenomena offer such a fascinating field of study that it is strange more experimenters have not turned their attention to the subject. It is a simple matter to construct the various cells that have been developed in the past, while the study has many possibilities.

The simplest form of photo-electric cell consists of two sheets of tin foil in a solution of salt water. One of the sheets is exposed to light while the other is kept in darkness. A modified form of this cell devised by Fleming can be constructed as shown in figure 1. A sheet of heavy tin foil measuring 4 inches square is wrapped around a wooden dowel ½ inch in diameter. A sheet of thin blotting paper is wrapped over the tin foil and a second tin foil wrapping applied. The whole can be held together with small rubber bands. A tiny wooden dowel serves to fasten the elements of the cell to the cork of the test tube. Tin foil leads are brought out through slits in the cork. The whole is placed in a test tube filled with water to which a little salt has been added.

With this form of construction, the inner tin foil plate is protected at all times from the light. When the cell is connected to a sensitive galvanometer a slight current will be detected, even with the cell in the dark. This is due to the fact that a current is generated when two electrodes are put in a solution, regardless how similar they may be in their physical appearance.

When a strong light falls on the cell a marked increase of current will be noted flowing from the shaded cylinder to the lighted one, in the exterior circuit.

In experiments with photo-electric cells some form of artificial light is preferred to sunlight. The light from burning magnesium ribbon is very satisfactory, but where lighting current is available an arc light is the better of the two.

A hand-fed arc light that can be easily constructed from parts on hand is shown in figure 2. The base is a shallow cigar box; a bent rod and a holder made from strip brass holds the upper carbon. The lower carbon is fitted into a tube that slides in a larger tube attached to the base. A slot cut in the fixed tube allows free movement of the brass lever to raise and lower the carbon holder. The lever is made from a switch blade drilled at the center and pivoted on a switch hinge clip. A threaded rod with an insulating knob serves to operate the lever. A water rheostat made from an Edison battery jar, 13 by 7 inches with circular plates 5 inches in diameter, will give the necessary current regulation.

Returning to the photo-electric cells, the Fleming cell can be improved by using silver foil for the plates. Still further improvement can be obtained by coating the lighted plate with silver salts.

A cell employing chloride of silver can be made as shown in figure 3.

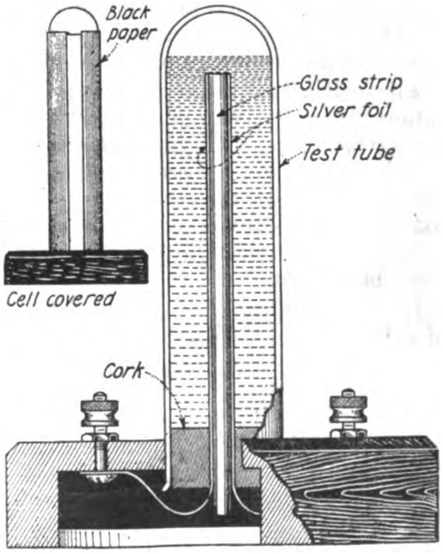


Figure 3—Photo-electric cell using chloride of silver for coating the lighted plate

Strips of silver foil are attached to a narrow strip of glass by means of melted pitch, the strips extending 1½ inches over one end. An emulsion is prepared, consisting of a little finely powdered silver chloride and collodion which are shaken together in a test tube in the dark, or at least the tube should be covered with black paper. Pour this emulsion on one of the silver plates in a dark room and allow it to dry.

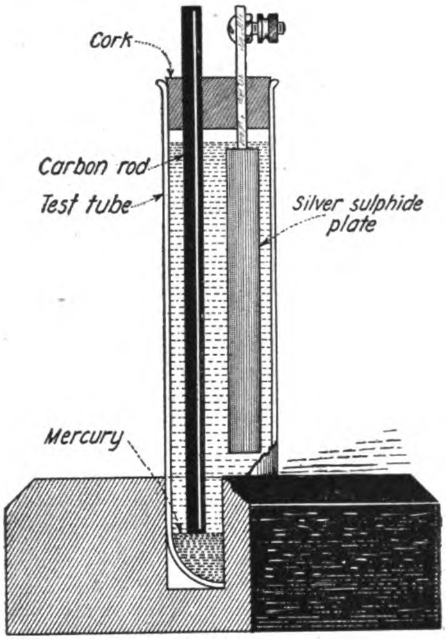


Figure 4—The Sauer photo-electric cell

The glass strip with the plates is now mounted in the test tube by cutting the cork in half and hollowing out the center so as to pass the strip tightly. The test tube is filled with distilled water to which a little table salt has been added. The cell can now be assembled and after making connections to the protruding strips of silver foil, the whole can be sealed with sealing wax as shown. The test tube is now covered with black paper with the exception of a space ½ inch wide down the side nearest the coated plate.

The cell when connected to a galvanometer will give a slight current in the dark, but when light from the arc is allowed to pass through the uncovered part of the tube on to the coated plate, a decided deflection of the galvanometer will be noted, the coated plate being positive.

If a solution containing a few drops of sulphuric acid is used in the cell the results will be the same. This indicates that the action is independent of the electrolyte, the salt or acid serving merely to reduce the resistance of the water.

This cell is fairly sensitive; dull sunlight will give a current and even a candle will cause a deflection if a sensitive galvanometer is used. It will be noted also that the current generated varies directly as the strength of the light falling on the cell.

Different colored lights will also give varying current strengths. The light from the violet end of the spectrum has the greatest effect, while the effects of red are scarcely noticeable.

Similar effects may be observed if any of a number of other silver salts are employed for coating the plate. Thus a silver bromide emulsion may be made as explained, keeping it away from the light while preparing it. A few grains of potassium bromide is added to the water in the cell. A mixture of silver nitrate and rather thin gelatin may also be used with the results noted, barium nitrate being used in the solution.

Possibly the most sensitive cell using silver salts is that devised by Sauer. A cell of this type may be constructed as shown in figure 4. A large test tube contains at its bottom a small quantity of mercury, to which connection is made with a thin carbon rod. If preferred, a platinum wire can be sealed into the bottom of the tube to make this connection. A plate of silver sulphide is supported in the upper part of the tube and in a position to be freely acted upon by the light. The solution used in the cell consists of 100 parts water, 15 parts common salt, 7 parts copper sulphate. The cell is mounted upright in a wooden block.

This cell is very sensitive to light and gives quite an appreciable current. The rapidity with which it follows variations in light intensity would make it suitable for registering light variations, and perhaps with modifications, would make it rank a close second to the unreliable selenium cell.

The reaction taking place in this cell is rather complicated and is thought to be as follows: The copper sulphate and salt (sodium chloride) form a cupric chloride which is reduced to cuprous chloride by the mercury. The cuprous chloride acts on the silver sulphide plate in the presence of light to form silver chloride with the result that a current is generated.

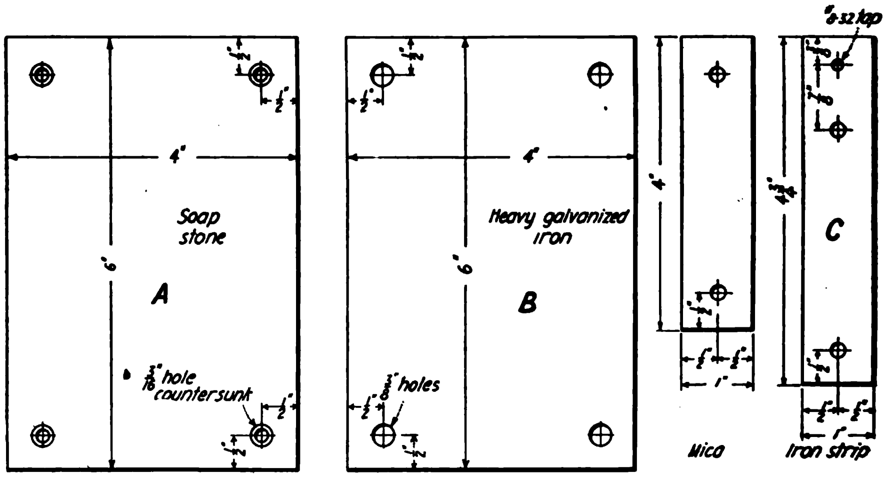


Figure 5—General plan of construction of the graphite laboratory stove

Another type of cell that is rather sensitive employs copper plates. The one under the influence of light is oxidized while the other can be left plain. A strip of thin copper is oxidized by holding it in a Bunsen flame until black. Another similar strip is cleaned with sand paper. The two are then fastened to a strip of glass in a manner similar to that employed with the silver cells. The details of the mounting are the same, a few grains of copper sulphate being added to the water in the cell. The test tube is covered with black paper, excepting a space down the side nearest the oxidized strip.

This cell will give a fairly strong current in bright sunlight. By coloring the plate exposed to light with such dyes as eosin, malachite green, or napthol yellow, the effect will be increased. It will be found also that the violet end of the spectrum gives the strongest current.

In all probability the following is the true explanation of the action of all photo-electric cells: Ultra-violet light, whose waves are shorter and more rapid in vibration than the visible violet rays, has a marked reducing effect on many chemicals in solution. Oxidization or reduction at any pole in a solution will produce a current of electricity. This would then explain the action in the case of cells employing silver salts, for their reduction by light is utilized in photography. Furthermore, it has been found that some metals when immersed in a solution and exposed to strong ultra-violet light throw off tiny charged particles in what is termed a collodial condition. This cannot be done without leaving an opposite and equal charge on the plate, and the result is the passage of this charge to the other pole not so exposed. This, then, must be the action in cells employing similar plates for the electrode as the Fleming tin foil coil.

Summing up, a photo-electric current is produced in two ways. First, by the use of a cell in which the chemical action depends on the presence of light. Second, by a cell that depends upon the discharge of negatively charged particles under the influence of light to cause a disturbance of the electrical equilibrium between the poles. The latter type is, strictly speaking, the true photo-electric cell and this form no doubt will solve the problem of utilizing the sun's energy. Further investigation of metallic colloids may add considerable to our knowledge of photo-electricity.

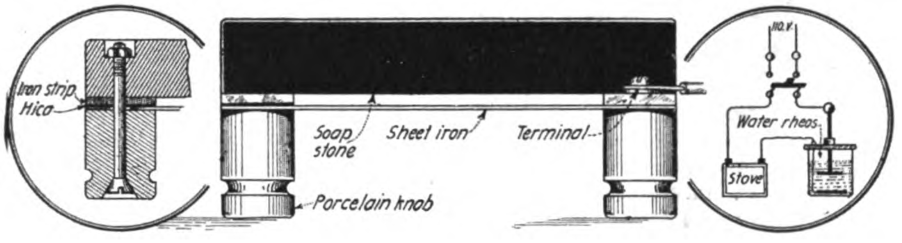


Figure 6—Graphite laboratory stove assembled

A Graphite Laboratory Stove

Although graphite is a conductor of electricity, it differs from metals in that its resistance drops as the temperature increases. If it could be evenly distributed in sufficient quantities on a smooth surface and made to adhere with sufficient tenacity, it would be a convenient means for generating heat by electricity up to the point where graphite is burned by the oxygen of the air.

Unfortunately the rubbing of graphite alone on a surface does not give a coating heavy enough to conduct an appreciable amount of current. Although it can be applied with a brush in the form of a paste, the results are very unsatisfactory, for it flakes off easily.

This makes it necessary to use some form of binder, but because they are not able to stand the high temperatures to which graphite can be submitted without harm, the maximum temperature of the device is limited. However, very satisfactory heating units for the laboratory can be constructed in the manner hereafter described.

The mechanical details are of little importance, but the form of stove described will fill the usual requirements of the experimenter's laboratory.

From soapstone ⅞ inch thick cut a piece measuring 4 by 6 inches. This is drilled as shown in figure 5, the holes being countersunk to a depth of ⅜ inch with a ⅜th drill.

Two strips of iron ⅛ inch thick, 1 inch wide and 4¾ inches long are procured. These strips are drilled as shown at B in figure 5. A sheet of heavy galvanized iron 4 by 6 inches is cut and drilled with holes as shown at C, figure 5. Two strips of mica 4 inches long and 1 inch wide with a hole punched at each end, four 8/32 flat head iron bolts 1½ inches long, and four porcelain knobs 1 inch in diameter and 1 inch high, are required to complete the stove.

The graphite used in constructing the stove can be purchased in the form of a well known stove polish on sale in every grocery store. This is to be mixed with water and applied with a brush.

Lay the soapstone slab on a tripod or other support and arrange to heat it with a bunsen burner. Take the two iron strips and smear them thickly on one side with the stove polish; similarly treat the ends of the soap stone slab where they will be fastened. Lay them on the slab and drop bolts through the holes to keep them in position. By means of screws in the end holes of the iron strips connect them to the 110 volt supply through a lamp bank or other resistance.

Heat the stone with the bunsen burner till it is hot enough to evaporate water rapidly but without sputtering. Apply a rather thin coating of the paste with a brush to the surface of the stone, using long strokes. Cover the entire surface on each application but do not pass twice over the same place with the brush. The stove polish is known as X-Ray Stove Polish.

After each application polish the surface vigorously with a stiff toothbrush. As the process continues the graphite coating will soon become thick enough to conduct electricity, which will then serve to heat the stone. If an ammeter is handy it should be connected in the circuit and the application of graphite continued until two amperes flow in the circuit. In the absence of a meter, two 50 watt incandescent lamps can be connected in parallel and when these light to full brilliancy the coating is heavy enough.

When the stone has cooled the stove can be assembled. Remove the bolts from the corner holes without disturbing the iron strips, lay a strip of mica on each iron strip, cover the whole with the galvanized iron plate, centering the small holes in the strips with the larger holes in the plate. A bolt is then dropped through each porcelain knob and the protruding end of the bolt passed through the stove unit and fastened thereto by a nut fitting into the countersunk holes on the top surface of the soapstone slab. When all four legs are securely bolted in place the stove is complete.

Connections are made to the extending iron strips, a water rheostat being included in the circuit to control the current and hence the temperature of the stove. The temperature should not exceed 400° C. Before using, the stove should be matured by heating to 400° C. and kept there for two or three hours. Thereafter its temperature at any given current input will be fairly constant. The assembly is shown in figure 6.

Speaking Incandescent Lamp

Those having the facilities may perform the rather novel experiment of making an incandescent lamp reproduce words spoken into a telephone transmitter.

A 500 watt, type B, mazda lamp is connected to the 110 volt direct current supply as in figure 7. Shunted across the lamp, as shown in the diagram, are the secondary of a telephone induction coil and a ½ mfd. condenser. A telephone transmitter and six dry cells are connected to the primary of this coil.

On speaking into the transmitter the lamp will reproduce the words, which can be heard when the ear is held rather close to the globe.

To explain the action we may suppose that the voice currents are added to the current flowing in the lamp circuit, causing it to burn more or less brilliantly. The resulting changes in temperature are communicated to the glass and thus to the air. It is not improbable that some similar arrangement might be used to modulate the waves emitted by the electronic relays used in short range wireless telephones.

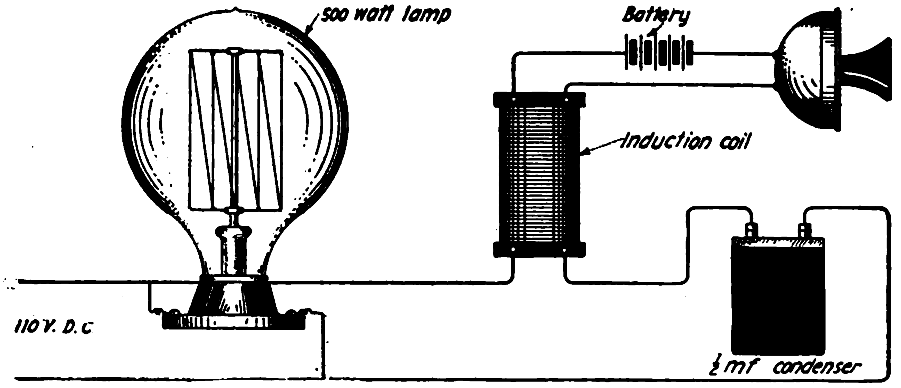


Figure 7—Diagram showing connections and installation of the speaking incandescent lamp

Hot Wire Ammeter

By C. J. Fitch

ARTICLES have appeared in the various magazines describing the construction of a hot wire ammeter for the wireless experimenter, but the main objections to these meters are the uncertainty of the zero positon on the scale, and inaccuracies due to a change of the surrounding temperature. To overcome these disadvantages I designed the meter shown in the diagram, figure 1.

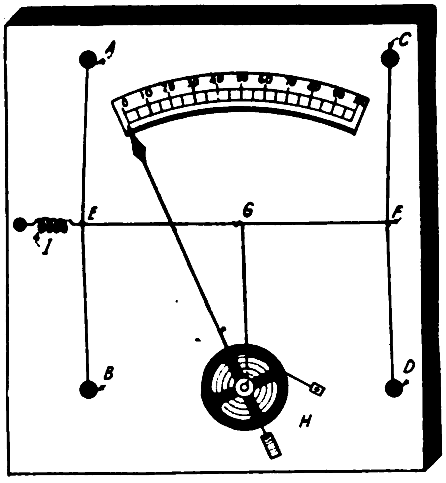


Figure 1—Design of the hot wire ammeter

Two resistance wires AB and CD, each 4 inches long by .003 inches in diameter, are clamped between binding posts, using a paper washer to prevent slipping. EF is a silk thread 4 inches long. Another thread is tied at G and wound around the shaft on which the hair spring H is mounted. The hair spring tends to move the pointer to the right, but it is held on the zero position by the silk thread. The hair spring and its bearings were taken from an old alarm clock. I is a small spring, or rubber band, which should be very strong as compared with the hair spring. The pointer is cut along the band of a folded paper to give it stiffness. It is fastened to the shaft with a bit of sealing wax, by melting it off the point of a file.

If the wire AB expands, the spring I will pull up on G and move the pointer to the left. If the wire CD expands, it will slacken up on G and the hair spring will move the pointer to the right. It is evident then, that when both wires expand or contract alike, due to a change of the surrounding temperature, the pointer will not move. The current to be measured should flow through the wire CD. The meter may then be calibrated by comparing it with a standard instrument.

Those who have a larger meter at hand, or who wish to make extremely small measurements, should note the diagram, figure 2. Here the wire AB has a shunt in parallel with it, and the instrument is connected in series with an adjustable rheostat, the large meter and a battery. The scale of the meter is also changed as shown.

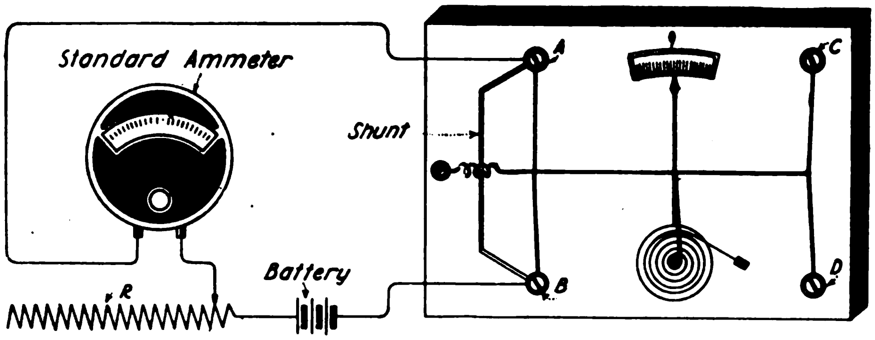


Figure 2—Showing the hot wire ammeter connected up for calibration

The current to be measured is passed through the wire CD, which moves the pointer to the right of the zero position. By adjusting the rheostat R, the value of the current flowing through the wire AB can be varied until it equals the current through CD, and the pointer will move back to zero. At this position the reading of the large meter should be taken and divided by the ratio of the shunt across AB. This result will be the value of the current through CD. For example, suppose the shunt has such a resistance as to allow 1/100 of the current to pass through AB. When .01 ampere flows through CD, to bring the pointer back to zero, .01 ampere should flow through AB, or 1 ampere through the large meter, which can be read more accurately. In this case a rheostat of 5 ohms maximum should be used, with a battery of two dry cells.

QRM Amongst Amateurs

THE articles I have read from time to time regarding wave length restrictions, interference, power input, etc., do not seem to present the solution to the problem. Nor will I pretend to offer a complete solution; but I have some suggestions which may prove of interest.

There are those who apparently believe that by requiring a speed test of from 15 to 20 words a minute, a minimum amount of interference between amateur stations would result. In my opinion, such would not be the case. I have heard the 20-words-a-minute man QRM the air to as great an extent as anyone else and, at times, there were some who seemed to think that their superior operating ability entitled them to hold the ether indefinitely.

QRM is QRM any way you may take it, and the imperative thing is to eliminate it in a systematic manner. This elimination will come in time, but only as experience suggests the remedy. I cannot see that the amateur would be any better off with a speed requirement of 15 words a minute, from a QRM standpoint. I must confess that I am not sufficiently informed to determine the best method for controlling QRM, or the amateur, but I do not believe that the solution of the trouble lies in the matter of speed.

In my opinion, the requisites for a *transmitting license* should be based upon the following:

1. Character and responsibility of the applicant.
2. Care and operation of apparatus.
3. Knowledge of the laws pertaining to the amateur.
4. Application for license to be approved by nearest recognized radio club or association, before being filed with radio inspector. No transmitting license to be granted unless this is done.

Advanced amateurs can help educate those who are striving for a license to operate their apparatus so as not to cause needless interference. I refer more particularly to the small boy and the irresponsible person.

I believe that radio clubs throughout the country, if they are permitted to do so, can solve the amateur problems better than anyone else.

As to power input and wave lengths, I make these suggestions: Let the standard wave be 250 meters. Relay work on trunk lines should be conducted at 425 meters, and certain hours aloted for trunk line work. All stations not officially designated as trunk line stations should operate on wave lengths not exceeding 250 meters. This will effectually eliminate interference with relay work, or at least reduce it to a minimum. Official relay stations when operating between each other during relay hours, except for trunk line work, should be compelled to confine their operations to a wave length not exceeding 250 meters. This is only meant as a suggestion, as conditions in some localities may warrant something different from the actual figures I have given.

The standard power input should be 1 kw. except for those stations situated within a certain distance of government stations, when it might be advisable to curtail the power.

W. T. Gravely, *Virginia.*

Donle's Variable Condenser

IN the usual type of rotary variable condenser, the capacity is almost directly proportional to the movement of the rotary plate. Although this type has proven fairly satisfactory for radio work, it possesses certain serious defects. For one thing, the percentage variation in capacity is small for it is impossible to adjust with any degree of accuracy below a certain point on the scale, say 15 degrees, and because air is the usual dielectric, a condenser of small capacity occupies considerable space. Furthermore, in the usual type, the rotating plates tend to throw the shaft out of balance so that a slight jar results in a movement which is sufficient to destroy the adjustment. This is quite a serious defect on shipboard.

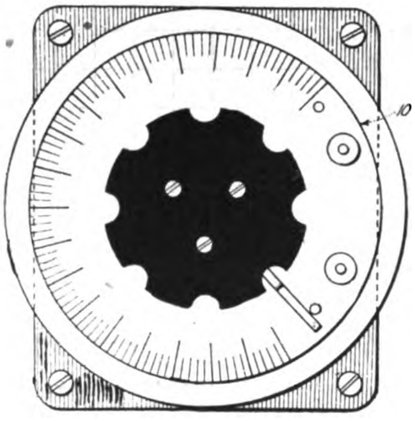


Figure 1—Top view

In the construction shown in the accompanying figures 1 to 8, the inventor employs a pair of condenser plates one of which is covered with a thin layer of mica or light dielectric material, the capacity being varied by the adjustment of the plates in respect to each other; that is, the plates are shifted toward each other so as to avoid a rubbing engagement.

Figure 1 is a top view; figure 2 is a side elevation; figure 3 is a cross sectional view taken on the plane of the line 3-3 of figure 1, showing the condenser plates in a partially separated condition; figure 4 is a similar view showing the condenser plates brought together. Figure 5 is a bottom plan view of the device with the bottom cover removed; figure 6 is a detailed sectional view of one of the binding posts, showing the flexible connection therefrom to the movable condenser plate; figure 7 is a cross sectional view of a slightly modified form; figure 8 is a bottom plan view of the main portions of the device and figure 9 shows graphs plotted from some of the results obtained with the device.

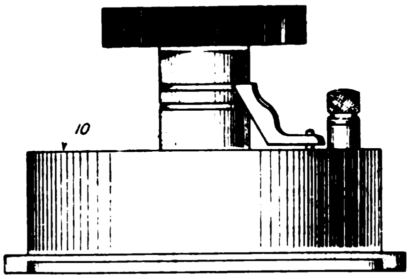


Figure 2—Side elevation

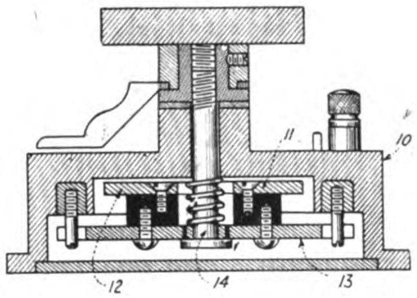


Figure 3—Cross sectional view

In the first form illustrated, a metallic supporting base 10 is provided, made hollow to serve as a casing for certain of the parts, and constitutes a plate or condenser element 11. The second condenser plate is designated at 12 and is shown as housed within the hollow base opposite the condenser surface 11. This condenser plate is insulated from its support by a block of insulating material 13, having a central passage through which the stud 14 extends.

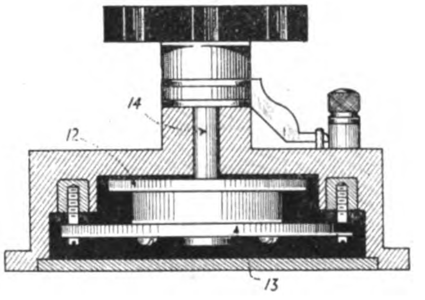


Figure 4—Cross section showing condenser plates brought together

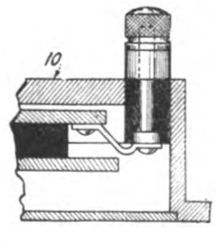


Figure 6—Detailed sectional view of one of the binding posts

A layer of dielectric material is interposed between the condenser plates, mica having been found a desirable material. It is secured to the face of the upper condenser plate in the illustration.

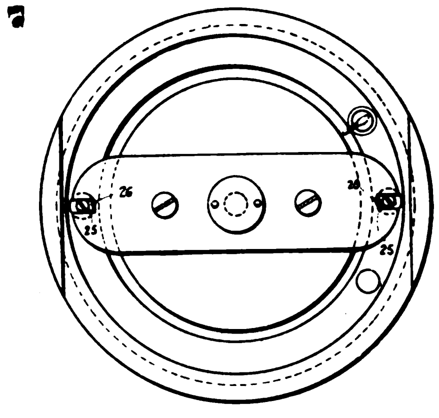


Figure 5—Bottom plan view

The construction illustrated in figures 7 and 8 is similar to the preceding figure, the main distinction being that in the latter form, the hollow base 10′ is made of insulating material; this necessitates applying a separate metallic condenser plate 11′ to the underside of the base as the opposite element of the movable condenser plate; the secondary condenser plate in this case is secured directly through the operating screw without any insulation.

In this construction, the movable condenser plate is guided in a straight path into engagement with the other condenser plate by forming the guiding slots 26′ directly in the peripheral portion to receive the guide studs 25′.

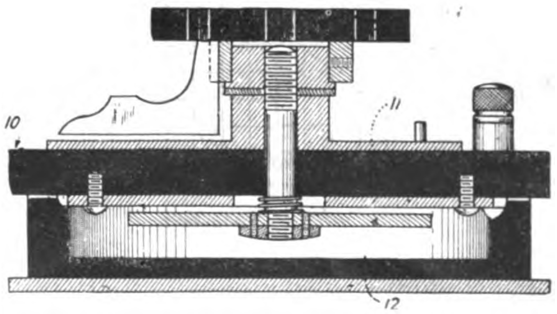


Figure 7—Cross section of a modified form

Some of the results obtained from the condenser are shown in the graphs figure 9. The horizontal graduations from 0° to 10° indicate figures on the condenser scale, the vertical graduations indicating the capacity in microfarads. The solid black line indicates results of an actual test using an adjusting screw of thirty-six threads to the inch. The range of control and the ease of adjustment will be apparent from the curve. The dotted line indicates the calculated results using mica of approximately five ten-thousandths of an inch in thickness as the dielectric; the dot and dash line indicates calculated results without the mica. The dash line indicates results

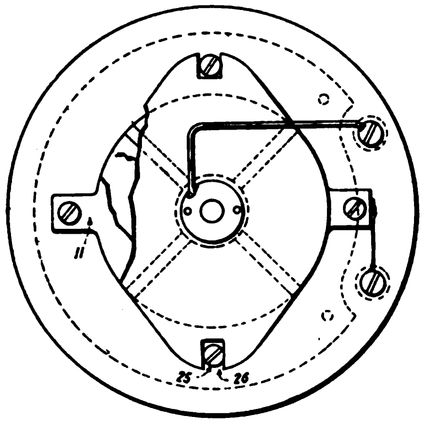


Figure 8—Another bottom view of the main portions of the variable condenser

using an adjusting screw of sixty-four threads to the inch.

The capacity of the condenser without the mica, neglecting edge effect, would be inversely proportional to the separation of the plates. With the one plate, however, covered with mica, (which material has a dielectric constant of approximately six times that of air) the capacity would be inversely proportional to $\frac{M}{K} + A$: where M equals the thickness of the mica, K equals the dielectric constant of mica, and A equals the distance from the outer surface of the mica to the other plate.

It will be apparent from the shape of the solid line curve that this type of condenser is especially valuable for use in a wave meter or in the wing circuits of a vacuum tube detector.

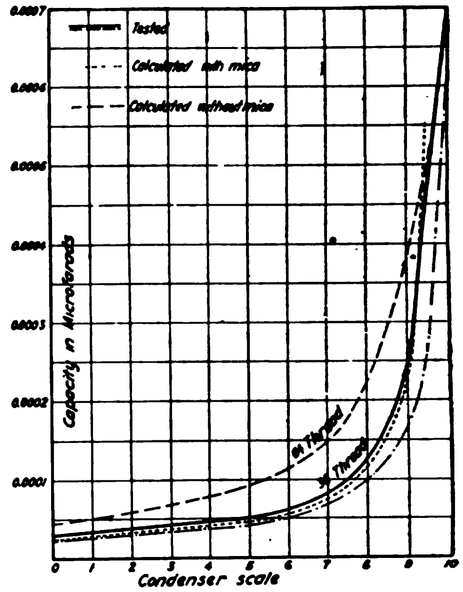


Figure 9—Graphs plotted from some of the results obtained

Locating the Taps on a Tuning Coil for Equal Increments of Inductance or of Wave Length

By Ralph R. Batcher

THE tendency in the past few years has been to replace the sliding contacts on the inductance coils of receiving sets with multi-point switches. It may prove advantageous in some cases to bring out taps from the coil so that each section would add a definite amount of inductance to the circuit. In other cases it would be desirable to divide up the coil so that each section would produce an increment proportional to $\sqrt{L}$; or, in other words, proportional to the wave length λ, since

$$\lambda \propto \sqrt{L}. \qquad (1)$$

For a single layer coil this is readily accomplished. It is necessary first to determine some relation between the inductance of a coil and the number of the turns. Lorenz's inductance formula for a single layer winding is perhaps the most simple one to use:

$$L = r\,n^2\,Q, \qquad (2)$$

where r represents the radius, n the turns, and Q a factor depending upon the ratio of $\frac{\text{diameter}}{\text{length}}$. The factor "Q" is obtained from handbooks for different values of shape ratios.

If it were not for the fact that in a single layer inductance all of the lines of force from each turn do not cut each of the other turns, the inductance would be proportional to the square of the number of turns. The fact is, that L varies as some power of the number of turns less than 2.

Changing equation (2) to read:

$$L \propto n^3\,\frac{Q}{n} \qquad (3)$$

and plotting $\frac{Q}{n}$ one gets a curve having the appearance of a hyperbola.

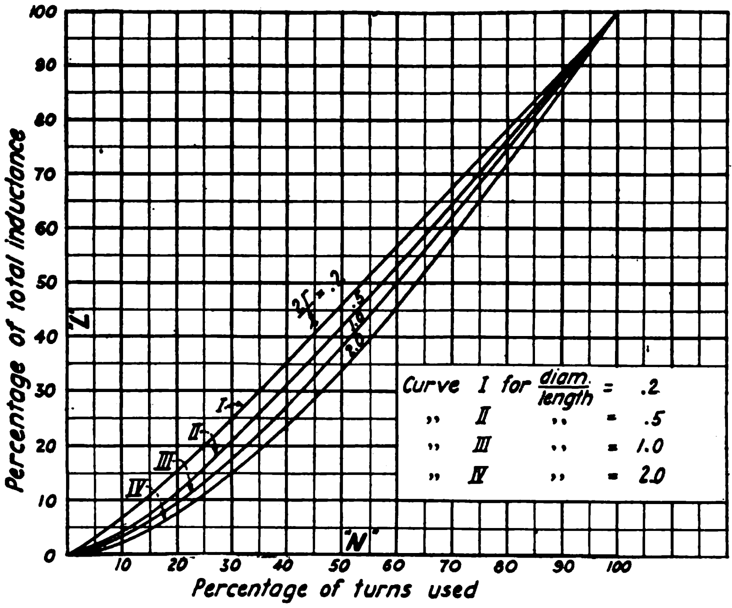


Figure 1

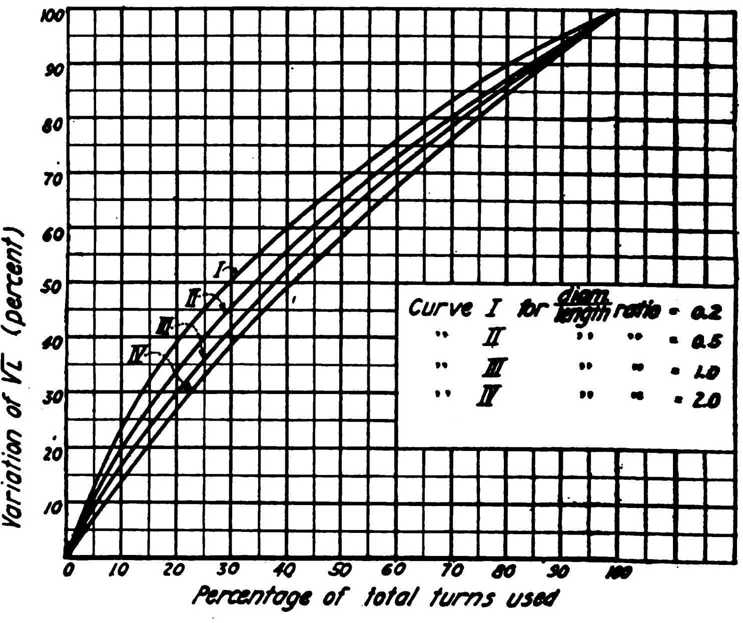


Figure 2

An equation roughly representing (3) deduced from the curve follows:

$$L \propto n\left(1.45 + \frac{\text{length}}{8\ \text{dia.}}\right) \qquad (4)$$

The equation shows that the inductance is more nearly equal to the first power of the number of turns than to the second power.

As this equation is a rather difficult one to use, curves have been constructed to show this relation graphically. To obtain greater accuracy, these curves have been plotted from the original formula rather than from equation 4. The curves represent four values of shape ratios but interpolation for other values of $\frac{\text{diameter}}{\text{length}}$ is a simple matter.

An example of how the curves may be applied in practice is as follows: Suppose it is desired to divide a coil 15.75" long, 7.87" in diameter having 400 turns of wire, into eight sections (the taps leading to a nine point switch), so that inductance could be added by equal amounts. The total inductance of this coil is 12.9 millihenries. Referring to curve II on figure 1:

Tap		Inductance	Millihenries
1	located on first turn gives	0% =	0
2	" " 84th " "	12.5% =	1.61
3	" " 138th " "	25.0% =	3.22
4	" " 185th " "	37.5% =	4.83
5	" " 228th " "	50.0% =	6.45
6	" " 272d " "	62.5% =	8.06
7	" " 316th " "	75.0% =	9.66
8	" " 358th " "	87.5% =	11.27
9	" " last " "	100.0% =	12.9

If this coil were to be used alone as the secondary coil of a receiving transformer, the taps might be taken off according to the curves of figure 2. In this case taps should be taken off from turns 1, 27, 84, 91, 136, 190, 252, 320, and 400. This will insure a constant wave length increment for each additional section of the winding cut in the circuit. (If a secondary loading coil is used these results will not be strictly correct.) Shunted with a .0005 mfd. condenser the wave length on each of the respective points would be: 0, 600, 1800, 2400, 3000, 3600, 4200, 4800 meters, neglecting the distributed capacity of the coil.

Group Frequency Tuner

WHAT we are told by the inventor is a novelty in the wireless telegraph art but which is well understood by wireless engineers is the group frequency tuning apparatus described by John Hays Hammond, Jr., in a recent patent specification.

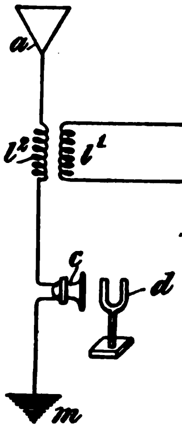


Figure 1—Transmitting apparatus

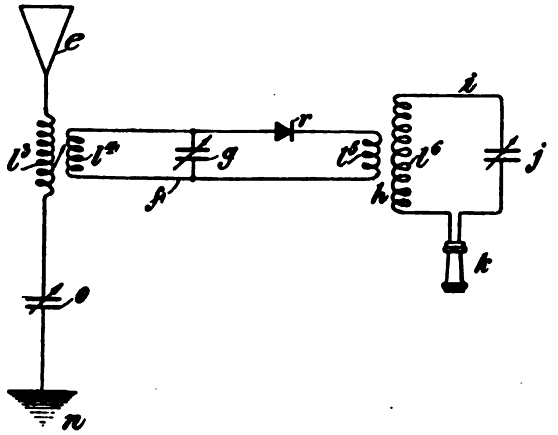


Figure 2—Receiving apparatus

The transmitting apparatus is shown in the accompanying diagram, figure 1 and the receiving apparatus in figure 2. In figure 1, a source of undamped oscillations B is coupled to a transmitter aerial inductively at the oscillation transformer L-1 and L-2. A resistance changing device such as C (which may be a microphone) is placed near a tuning fork D which can be replaced by any device operating at audio frequencies which is capable of modulating the antenna oscillations. When D is set into vibration, periodical changes in the amplitude of the antenna oscillations occur and consequently the signals can be received by any detecting apparatus responsive to damped oscillations.

The inventor attaches to his receiving apparatus as in figure 2 an audio frequency tuning circuit comprising the secondary inductance L-6, the variable condenser J and head telephone K. As is possible with all group frequency tuners, selectivity is obtainable not only by radio frequency tuning, but by audio or group frequency tuning as well, that is, for best response the operator must vary the natural frequency of the audio frequency circuit L-6, J, K, as well as adjust the radio frequency tuning elements of the receiving transformer. The inductance of L-6 is obviously very large for the frequency 500 cycles.

What Is the Most Efficient Receiving Set for Amateur Use and What Should Be the Dimensions of the Aerial and Tuning Coils?

THERE are many short wave regenerative receiving sets on the market, all of which are as good as present-day knowledge of radio telegraphy can make them; but for the benefit of the experimenter who prefers to assemble the apparatus himself, I am presenting the hook-up and dimensions of what is, in my opinion, the most efficient short wave receiver.

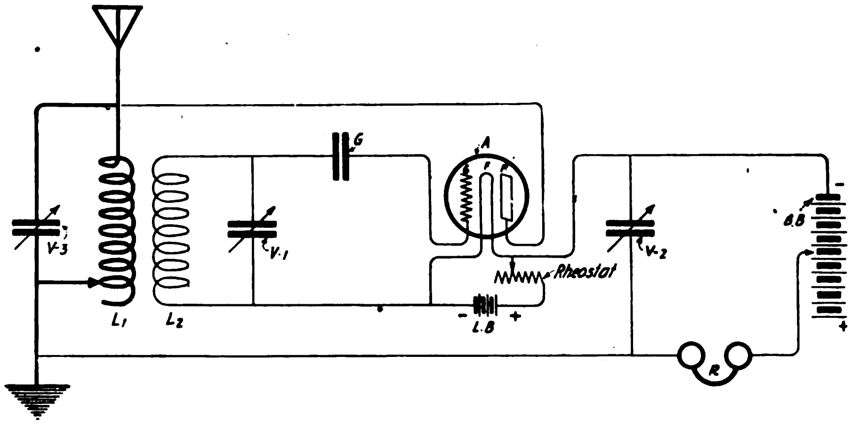


Figure 1—Circuit for the amateur receiving set

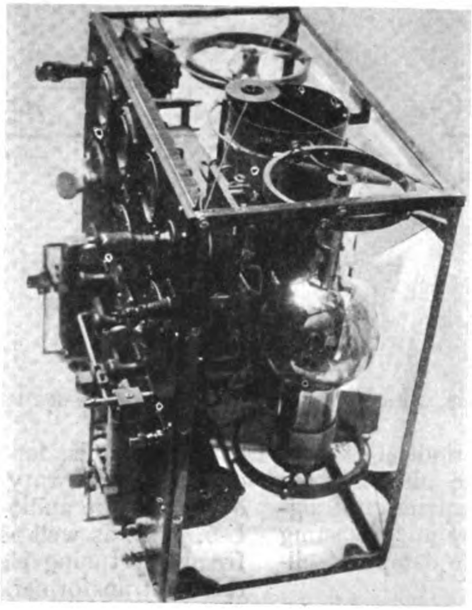
A receiving set for short waves should have low resistance, stability of adjustment, reliability and be easy to operate. It should be highly selective and is preferably fitted with an end-turn switch.

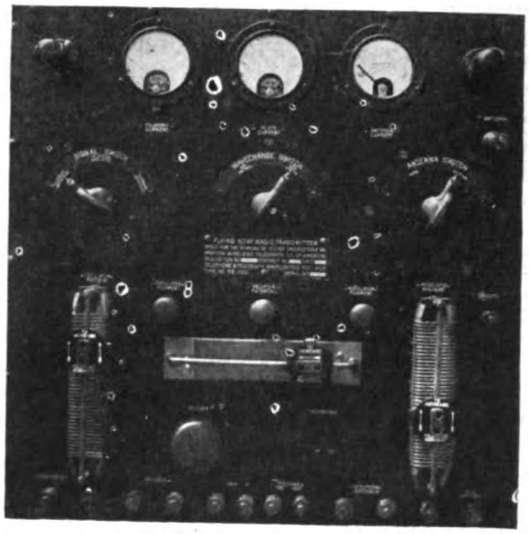
THE AERIAL

If a well balanced, efficient receiver is desired, the size and location of the aerial must be taken into consideration, as well as the other components of the receiving set. An aerial of the following dimensions will be found most satisfactory—4 to 6 No. 14 bare copper wires, spaced three feet apart, one hundred feet long and sixty feet high. The aerial may be supported by different means, but for strength and durability, I have found that a mast consisting of three joints of 20' iron pipe, of 3", 2" and 1" diameters respectively, connected by reduction

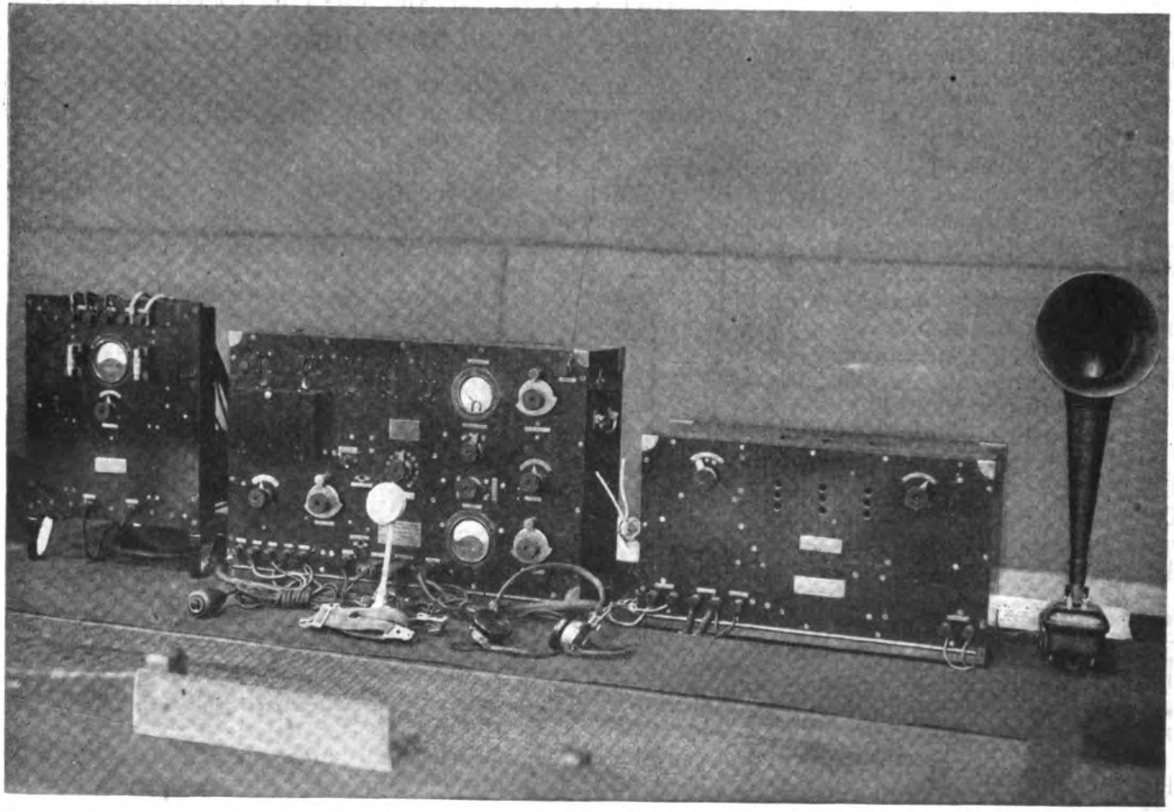
Wireless 'Phones

Photos, Intl. Film.





To the left: An interesting view of the Marconi transmitter used on naval flying boats, showing the arrangement and installation of the vacuum tubes and the means of control. **Above:** A front view of the same set showing the registering devices and control handles. At the top are the ammeters for filament current, plate current and antenna current; the three switches below are for the following purposes: the Signal Switch effects the change from telegraph to telephone; the Wave Change Switch changes the radiated wave from 600 to 1600 meters; the Antenna Switch has the usual send and receive positions. The rheostats regulate filament current and are respectively connected to oscillator and modulator



The radio ground set and amplifier of the Signal Corps as exhibited and demonstrated at the recent New York Aeronautic show couplings and well guyed to be permanent and substantial. After coupling the sections together, drive an eight foot, creosoted, locust post securely into the base of the mast, about two feet, so that when the mast is raised it will be supported on the post, which should be set three feet in the ground. This insulates the mast fairly well, preventing radiation losses to the ground when transmitting.

The aerial should be located so that no trees, smokestacks, wires, buildings or other objects are directly under it, as these will cause some loss of energy, both in transmitting and receiving. The lead-in should be taken from one end, because if it is brought from the center it causes the aerial to sag, spoiling its appearance. The fundamental wave length of such an aerial is a little below 200 meters, making it possible to tune to amateur wave lengths without resorting to the use of a series condenser, and on the other hand it is large enough to permit efficiently the reception of 600 meter wave lengths and above provided a vacuum tube detector is employed.

Receiving Transformer

The loose coupler L-$_1$ and L-$_2$ in figure 1 should have enough wire to tune to 600 meters but not so much as to cause a dead-end loss when receiving 200 meter stations. The primary should consist of 60 turns of No. 18 S. C. C. copper wire wound on a tube 3½" in diameter and 6" long. The dead-end losses of this primary are negligible, rendering the use of dead-end switches unnecessary. The secondary should be wound with 125 turns of No. 24 copper wire on a tube 3" in diameter and about 6" long, taps to be taken off every six or eight turns. Precise tuning may be accomplished by the use of a small variable condenser, V-1 across the secondary.

Variable Condensers

Two condensers (variable) are sufficient for this set, but another condenser V-3 should be connected across the primary if close variation of the primary wave length is desired. Condenser V-2 should be a 43 plate, oil-immersed, rotary variable, while V-1 may be of 19 or 23 plates, not oil-immersed. Fixed condenser G is the usual grid condenser.

Detector

The valve A should be of the tubular type, and one which oscillates readily. It is sometimes difficult to obtain uniform oscillations from the bulb at high frequencies. The lighting battery L, B, for the filament is preferably a storage battery as it will prove much more economical in the long run than dry cells, because the filament draws a considerable amount of current. The high potential battery B,B may consist of ten three-cell flat, flashlight batteries, as these are compact and have long life. In place of regulating this battery, cell by cell, by means of a rotary switch, a high resistance potentiometer gives closer regulation. It should be connected in shunt with the cells being connected as any potentiometer.

Telephones

The mica diaphragm amplifying receivers are by far the most sensitive for wireless reception; they are also the least uncomfortable to wear for long periods and they fit the ears closely enough to exclude outside noises. If the cost of these is prohibitive, however, I would recommend any standard make of 2,000 ohm telephones.

Connections

All connections should be as short and as direct as possible. No. 18 wire is satisfactory. After the set is connected up, the aerial, ground and lighting battery connnections should be reversed until the best results are obtained.

Operation

The valves should be adjusted to a point below where a hissing sound is heard in the head telephones. This is the most sensitive point. This set is not affected by the proximity of the operator's hand or body, as in the Armstrong circuits, making it unnecessary to use long adjusting handles. For general "listening in," the coupling should be close, but by judicious use of the coupling when receiving through heavy QRM or QRN much of the interference can be eliminated.

It has been found that a magnet placed near some bulbs in a certain position, will increase its sensitiveness. The operator must determine by trial the correct position for the magnet.

It is to be noted that I employ regenerative coupling but instead of coupling the plate to the grid circuit, I connect to the antenna circuit, with equal results and with greater simplicity of operation.

The above described apparatus, connected according to the diagram will fulfill all the requirements for a simple, reliable and efficient receiving set for amateur wave lengths.

J. E. Law, Jr.—*West Virginia.*

A Variable Condenser Adapted for Small Variations in Capacity

In the ordinary type of variable condenser it is difficult to obtain a fine adjustment of the capacity values because a slight movement of the movable plate causes a considerable change in capacity. N. H. Slaughter has devised the variable condenser shown in figures 1, 2, 3 and 4, which permits a very close adjustment of its capacity.

He provides two sets of movable plates, one set comprising the bulk, which may be 10 or 20 in number, the other set having only a small number of movable plates, say 1 or 2. These sets are independently movable and both sets may be adjustably interleaved with the stationary set.

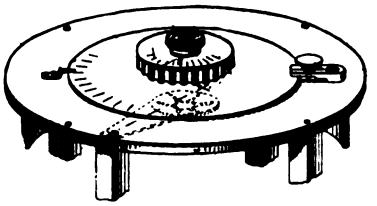


Figure 1—Top view

The construction is such, that the larger set of movable plates may be adjusted in any position to roughly give the desired capacity; and then for purposes of finer adjustment, the smaller set of the plates may be rotated to give the exact capacity desired.

In the drawings, the semi-circular plates 13 are approximately the same in number as the stationary plates 1. The shaft 15 is hollow and placed within the same is a shaft 18, to the lower end of which is clamped a single blade 19. This blade which provides for fine adjustment, is held in position by the shaft 18 by means of the clamping nuts 20 and 21 which are inserted on the shaft 18.

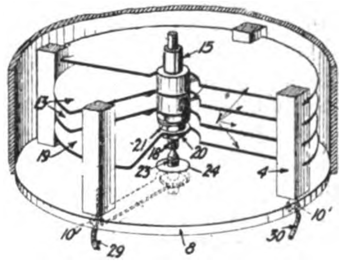
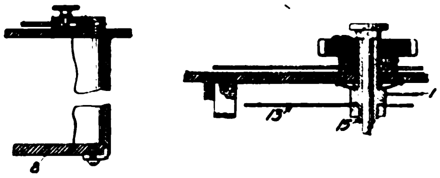


Figure 2—Interior view

Both of the movable sets of plates are carried by the shaft 18, the lower end of which is adjustably supported by the set screw 23, which is threaded in the bushing .24 in the bottom 8.



Figures 3 and 4—Details showing construction of frame and rotating shaft with semi-circular plates attached

Electrical connection may be made to the system by means of the lead 29 which is electrically connected to the movable plates by means of the set screw 10' which serves as a binding post. The other terminal is a lead 30, one end of which is electrically connected to the stationary plate by means of the set screw 10' which is screwed into the lower end of the standard 4.

The Design of 60-Cycle Transformers for Amateur Transmitters

(*Continued from page* 26)

With steel laminations .014 thick, a core 1.7 inches will require $1.7 \times 59 \times 4 = 404$ pieces in all; 202 of these should be cut 1.7 inches wide and $(5.2 + 1.7) = 6.9$ inches, say 7 inches, long. The other 202 pieces should be cut 1.7 inches wide and $(3.4'' + 1.7'') = 5.1$ inches, say 5 inches, long. The builder may be able to get these cut to these dimensions by the manufacturers of the steel.

We may now determine the efficiency of the transformer from the foregoing formula. Summarizing,

Primary copper loss = 8.36 watts
Secondary copper loss = 7. watts
Iron loss = 15.36 watts

$$\text{Therefore, Efficiency} = \frac{500}{500 + 15.36 + 8.36 + 7} = 94\%$$

ASSEMBLY

Stack up the laminations as in figures A and B and be sure to stagger the joints. Drive nails in a board as in figure C and lay on sheets until the pile is 1.7 inches thick. The ends of the cores are shown in figure D. Figure E shows how the yokes will appear finally. After making up two cores and one yoke like figure C, bind them with one layer of friction tape.

Next put 1/16 inch washers on primary and ⅛ inch washers on the secondary. These should be made of micanite. Next place the micanite tubes on the primary and secondary cores. Make them about the same thickness as their respective washers.

The winding form for the primary is 1.8 inches on side and 5 inches long. Put on one layer of fishing twine, then one layer insulating paper, and finally 238 turns of No. 13 DCC wire. Now take off one end of the form, pull out fishing twine, whereupon the coil will come off very easily. Next solder on 1 foot of No. 12 machine cable to act as leads and then dip the coil in clear insulating varnish and bake for about 6 hours. Then wrap it with one layer linen tape, lapping the tape for half its width and then place the coil on the core. This completes the primary.

The form for the secondary will be 1.9 inches square and 1.2 inches long. First wind it with cord and paper as the primary, and put on 85 layers of 85 turns per layer of No. 30 D.S.C. wire. Place 1 layer of .007 inch oiled paper between the layers, then solder on leads of No. 20 silk covered lamp cord. Now remove the coil from form and wrap it with one layer of empire cloth. Construct the other three coils the same way.

The builder may be able to get these coils wound by some manufacturer of armature and field coils. The wire should be wound very carefully in even layers. It may be better to allow a little of the paper to extend beyond the ends of the winding as in figure F.

To finish the job, place the four coils on the core and connect up as in figure G. Be sure to connect the sections so the current travels around the core in the same direction. Place the remaining yoke in position, carefully watching the ends. Secure the core with oak clamps and bolts as in figures H and I.

The transformer should be placed in a tank and the leads brought out through suitable bushings. The secondary bushings should have an insulating value of at least 20,000 volts. Fill the tank with transil oil and put on a suitable cover.

The transformer has a leakage reactance suitable for a condenser of .008 mfd. using a quenched gap. When used with a non-synchronous gap the number of studs times the R.P.S. of the gap motor should not exceed 400. A method of finding suitable condenser values for various transformers will be discussed in an article on resonance to follow.

Contest Winners for the May Issue

In response to the call in the March issue for manuscripts concerning "The use of a quenched spark gap in connection with an amateur's 60 cycle transmitter," prizes have been awarded to the writers of the following articles

First Prize—The Quenched Spark Discharger Is Not the Most Desirable from the Amateur Standpoint

NO one who understands the principles of radio engineering doubts that the quenched spark discharger is the most efficient gap yet devised for low powered transmitters. The writer, however, will attempt to show that the amateur in the majority of cases is not in a position to take full advantage of the benefits thus to be obtained, and as a consequence a non-synchronous rotary spark gap is the one to be preferred for amateur use.

In the first place, many amateurs are of the opinion that simply to substitute a quenched gap for one of the plain rotary type will result in increased antenna current and range of transmission; but it is safe to say that those who have tried to experiment have been amazed at the degree of *inefficiency* which the quenced gap brought about! In all probability it will be found that such amateurs have never been told the requirements of a radio transmitter that gives good quenching. It is not alone the quenched spark gap that prevents the interchange of energy between the open and closed circuits with the consequent double wave emission, but it is the design of the whole transmitter which must be considered.

To begin with, there must be a certain amount of magnetic leakage in the power circuits of the transmitter, for otherwise when the condenser discharges across the spark gap, the transformer is short circuited and the resulting arc at the gap is too powerful to be quenched out. This permits the antenna circuit to react upon the spark gap circuit and results in a double wave emission. This is substantially what the amateur with the average 60 cycle transmitter will find.

A transformer fitted with a magnetic leakage gap will give some relief; even the insertion of a reactance coil in the primary circuit of the transformer will help some, but the best results will be obtained with a transformer having a magnetic leakage gap and utilizing the principles of resonance; that is, the transformer circuit with the secondary condenser should be tuned near to resonance with the frequency of the alternator.

The operation is then somewhat as follows: Due to resonance, the secondary voltage of the transformer rises to the point where the spark gap breaks down. The resistance of the spark gap is then reduced and the secondary of the transformer is short circuited. This throws the transformer circuits out of resonance with the alternator, resulting in a very marked drop in the secondary voltage This drop in voltage combined with the heat dissipating qualities of the copper plates in the quenched gap permits the primary to oscillate only through two or three swings, whereupon the primary oscillations increase. The antenna circuit then oscillates at its own frequency at damping with a single wave emission.

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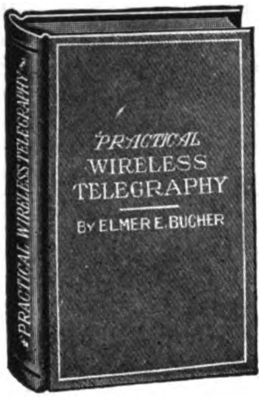

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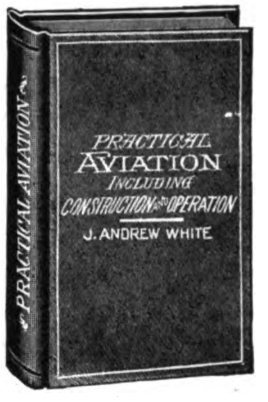

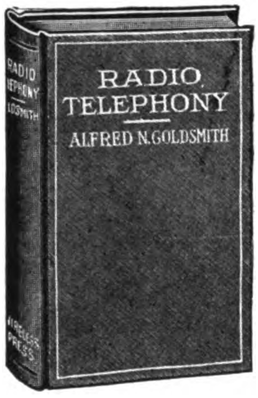

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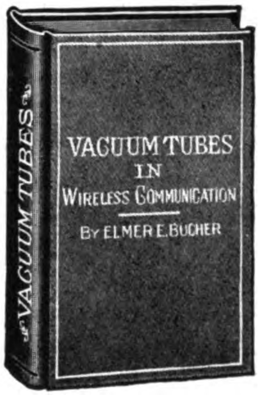

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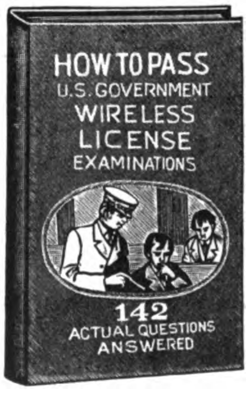

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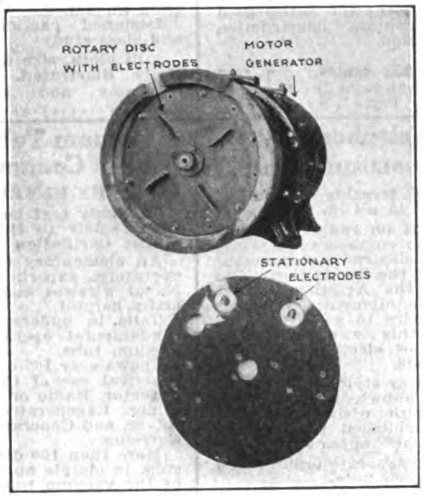
Experiment has proven that it is difficult to maintain a clear spark note with a resonance transformer, hence the natural frequency of the transformer circuit with its secondary condenser is designed to be 15 per cent or 20 per cent lower than that of the alternator. This prevents the breaking up of the spark note and still retains enough of the good effects of resonance to obtain the detuning results mentioned. In some types of transmitters like the Marconi quenched spark sets, the necessary magnetic leakage takes place at the alternator, the transformer being closely coupled; but since the amateur has no control over the source of power, he is required to obtain the necessary leakage at the transformer.



Synchronous rotary spark gap giving the high pitched note desired by amateurs

Suppose, for example, he possesses a transformer with a magnetic leakage gap and desires to operate near to the point of resonance. The necessary condenser capacity can be readily obtained in the following way: An ammeter is placed in the primary circuit, the key closed and the capacity of the secondary condenser varied until the primary ammeter reads the maximum. This indicates resonance. Then the capacity should be increased by 10 per cent to 15 per cent in order to slightly detune the circuit. With some types of transformers, the necessary capacity for resonance, or near resonance, may exceed .01 mfd. and as a consequence the amateur cannot operate on the wave length of 200 meters. If this is found to be the fact, he may obtain some relief by placing a reactance coil in series with the primary circuit of the transformer, using it, as well as the secondary condenser, to tune the circuit. By giving proper attention to the foregoing suggestions, very good results can be obtained with the quenched gap. There is, however, one all important factor that has not yet been taken into account.

Some experimenters are of the opinion that a quenched gap will increase the frequency of the spark discharge. This is not true. The quenched gap has the effect of smoothing out the tone of the spark, but at best the resulting spark note will be relatively low and will hardly compare with the musical note of non-synchronous rotary spark gap which amateurs are accustomed to employ. The average 60 cycle transmitter gives, with a quenched gap, what is known as a "mush" note, which, while it may be pleasing to some ears, cannot be said to be the most desirable tone. There are no ready means available to increase the tone of the spark except the type of transmitter which involves both a rotary spark gap and quenched gap. Some experimenters have placed these gaps in series using the rotary gap to increase the tone, and the quenched gap to give the necessary quenching. Experiments in circuits of this type do not always give the desired results. In fact the writer has found that the system is not very efficient.

This discussion, of course, does not include the rotary quenched spark discharger which has been supplied to the amateur market, but the writer has observed that these transmitters have such a large capacity in the closed circuit that they cannot be operated efficiently on a wave length of 200 meters. Such a large capacity results from the use of a low voltage secondary, usually no more than 2500 volts, but if it were not for that disparaging feature, it is safe to say that it would be employed universally by amateurs: for it is well known that a set of this type now supplied to the amateur market produces a spark tone equivalent to a 500 cycle transmitter.

Another item which experimenters should take into account is the cost of the quenched spark discharger. It has been the writer's experience that the expense of milling, cutting and casting the plates for quenched gaps exceeds the cost of a good rotary gap; and moreover, unless the amateur is willing to put the best possible construction into the quenched gap, he will find that it will not operate over a considerable period of time without trouble.

The average wireless experimenter prefers a high pitched spark note, or at least a note equivalent to a non-synchronous rotary gap. The writer has yet to see the quenched gap operated on 60 cycle current that will give a note equivalent to the non-synchronous rotary gap.

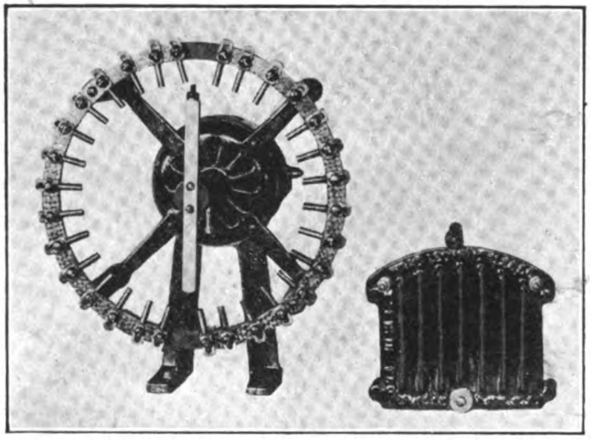
This discussion, of course, does not apply to 500 cycle transmitters, but since the amateur has not available a source of current of this frequency, the use of such frequencies need not be considered.

The writer firmly believes that in the future the approved transmitting set for amateur use will be one of the vacuum tube type, because these transmitters are rugged, fairly efficient, can be connected up to generate radio and audio frequency currents simultaneously and thus produce musical tones so desirable for all-around wireless transmission. No one has yet put such a transmitter on the market, but it is safe to say that one of these types will appear in due time.

A. J. Holborn, *New York.*

Second Prize—Arguments Against the Use of a Quenched Spark Gap in Connection with an Amateur's 60 Cycle Transmitter

In spite of the fact that the stationary quenched spark gap is considered to be one of the most efficient types of spark dischargers, it has not been extensively used by amateur experimenters. This is probably due to the reduced efficiency of the gap when operated on 60 cycle transmitters of the type amateurs are accustomed to use.


Non-synchronous rotary gap suitable for use with 60 cycle transmitters

A transmitting circuit containing a quenched gap operates somewhat on the principle of impulse excitation; that is, the oscillations of the condenser circuit are rapidly damped out by the quenching action of the gap, allowing the antenna circuit to oscillate at its own natural period. The gap operates most efficiently when the spark frequency of the condenser circuit is around 1,000 per second. At this frequency the oscillations of the condenser circuit, which are rapidly damped out by the quenching action of the gap, transfer impulses of oscillating current energy to the antenna circuit at a very rapid rate. In the case of a 60 cycle transmitter where the spark frequency of the condenser circuit is low, say 120 per second, the condenser circuit will transfer impulses to the antenna circuit at a very much lower rate with greater current at each impulse than in the case where the higher frequency is employed. This will increase insulating difficulties in the antenna circuit.

Many transformers used by amateurs are unsuitable for use with quenched gaps. The voltages in a great many cases are too high. When the spark frequency is high, the quenched gap has been found to operate most efficiently on low voltages which the amateurs cannot use, if they desire to employ the amount of power permitted by law.

The note of a quenched spark transmitter used with 60 cycle current is very low when heard at a distant receiving station. Furthermore, it has been proven by several radio engineers that currents of high frequencies around 1,000 per second will produce the same effect in a telephone receiver as currents, many times as great, at lower frequencies. Therefore, the receiving operator may hear a comparatively weak signal from a low frequency spark transmitter while a signal from a high frequency spark will be heard much louder, even if the received energy from both transmitters are the same. For this reason, a high pitched note has a great advantage over a low pitched note; and in some cases, a higher spark frequency will completely drown out a low pitched spark, simply because the telephone receiver is less sensitive to a low note than to a high one.

It is more difficult to receive a low pitched note through atmospheric disturbances. The higher pitched note of a non-synchronous rotary gap can be read with much greater ease; but it cannot be obtained from a 60 cycle quenched gap.

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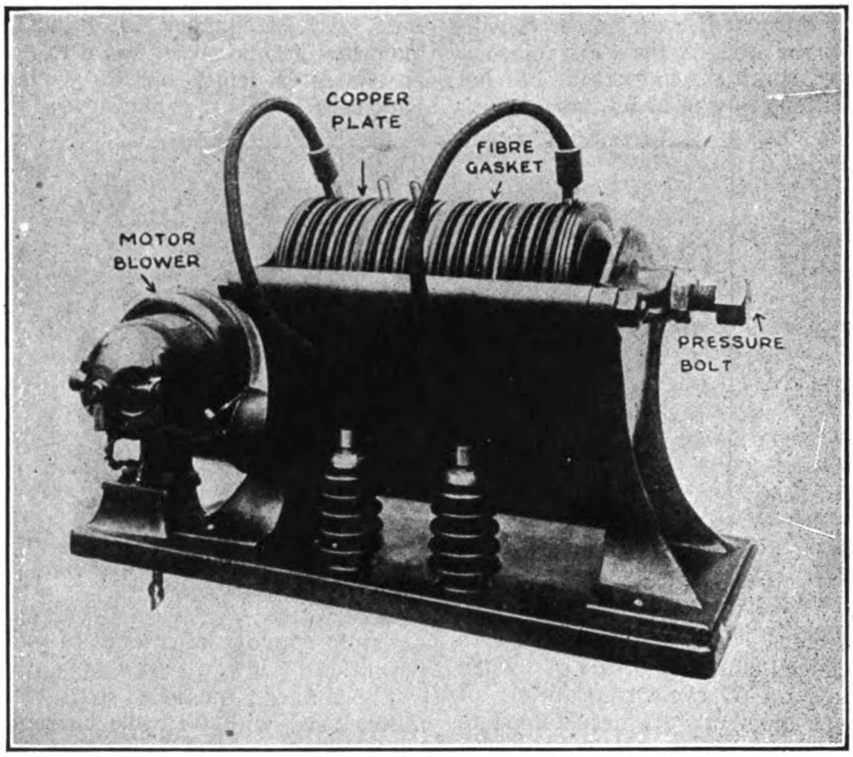
Third Prize—The Quenched Spark Gap and the 60 Cycle Transmitter

THE post-war restrictions imposed upon amateurs regarding power input will require the amateur to strive with increasing zeal to gain the highest possible efficiency out of his apparatus. The quenched gap, possessing as it positively does, 25 per cent greater efficiency than any other form of gap, will be used by the amateur to a greater extent than heretofore, if he is willing to sacrifice the spark note.



A quenched spark gap of improved efficiency

As is well known, 60 cycle current is not favored for signaling, due to its low frequency and unmusical pitch; the quenched gap will not improve that pitch. Reception is more difficult through static interference as compared with the more musical sparks of higher frequency and the reception of rapidly transmitted signals with low frequencies becomes rather difficult at great distances. This accounts for the popularity of the non-synchronous rotary gap, in which the spark discharges occur at the rate of 200 or 300 per second along the initial 60 cycle alternating current curve. But during the times of favorable atmospheric conditions and times when the ether is free from interference from other stations, as in midnight hours, very long distance work should be accomplished with a well balanced quenched spark transmitting set using 60 cycle alternating current. Such a transmitter will probably have a greater range under those conditions than one employing the rotary gap.

The superiority of the quenched gap is recognized by the commercial companies and the U. S. Navy, who use it to the almost entire exclusion of other forms, and the amateurs will profit by following a good example. A lower transformer secondary voltage can be used and the better quenching properties of this gap permits of closer coupling between the closed and open circuits, resulting in greater antenna current per given power input at approved decrement per oscillation. The noiseless qualities of the quenched gap should also be given consideration. A primary reactance may be employed to advantage to regulate the voltage of the primary current to secure synchronous discharges.

In summing up, we find that practical considerations oppose the electrical efficiency of this combination, but the latter no doubt exceeds the former. At least a greater number of amateurs should experiment along these lines, as intelligent results can be noted only from practical application to long distance work. Possibly the progressive amateur will provide both the rotary non-synchronous and the quenched gap, using each according to conditions.

HUGO L. ESTBERG, *New York.*

The Monthly Service Bulletin of the

National Wireless Association

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IMPORTANT NOTICE

All restrictions upon the use of wireless receiving stations, other than those used for commercial traffic, were removed on April 15th. The order applied to amateur, technical, experimental, and other stations. Restrictions on transmitting stations of all types remain in effect.

New England Gets Started

THE first post-bellum meeting of the New England Amateur Wireless Association was held at the Everett High School on February 13, with an attendance of about seventy-five. G. R. Entwistle presided.

A very interesting talk was given by Arthur Batcheller, New England Radio Inspector.

All amateur licenses both "operator" and "station" have been automatically canceled, and when stations are licensed again, new call letters will be assigned. This step is necessary to avoid confusion.

In order to secure a first grade amateur license one must be able to both send and receive not less than ten words a minute, and must also pass a technical examination.

The radio inspectors will visit the principal cities at certain periods notifying holders of these licenses two or three weeks beforehand. These men will be expected to appear and take an examination for a first grade license. Those who do not appear or advise the inspector of their inability to do so, will be regarded as no longer interested and their licenses will be canceled.

The law regarding interference will be as strictly enforced among amateur stations as it now is among commercial stations.

The fact that the majority of New England's 2,500 licensed amateurs enlisted, speaks strongly in favor of continuing amateur radio. These men were enabled to take up their duties without special training, thereby saving the government a vast amount of time, which was at such a premium in those strenuous days when every second counted. A committee was appointed to secure permanent quarters for the club.

The association would like to hear from its old members, also from those interested in becoming members. Communications should be addressed to the secretary, Mr. P. W. Pratt, 100 Harvard St., Everett, Mass.

Until further notice a meeting will be held once every two weeks.

Suggestion for Prize Contest, June Issue Wireless Age

We will pay the usual prizes of $10, $5 and $3, in addition to our regular space rates, to the three contributors who send us the best manuscripts on the following subject:

"To what extent do you believe that wireless telephony will take the place of wireless telegraphy in amateur communications?"

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Amateur wireless lost an ardent supporter and generous co-worker by the death of Corporal Harry V. Roome of Los Angeles. According to word received by his mother the young soldier died September 30 of gunshot wound and pneumonia.

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gaged as wireless instructor. Later he went to France and saw active service in the Signal Corps. The last letter written by him was dated September 15. Corporal Roome was a graduate of the University of Southern California.

A Voice From the Rhine

NOW that hostilities have ceased and peace is in sight, it is urged that amateur stations be permitted to reopen immediately. The most important reason is, that it trains the young amateur for war-work as was clearly shown in the past two years. While we do not expect another war to follow immediately, this is an age when preparedness is an important factor and the United States should never be caught again so wholly unprepared to defend the rights of her people. I was a radio operator in the Army throughout the recent conflict and it has been a matter of keen interest to me to note how well the former amateur played his part and how comparatively inefficient was the man without any previous wireless experience. Practically all the former commercial operators were needed at their old positions and it was up to the amateur to play the leading rôle which he did in every radio organization I have come in contact with.

Now as to the commercial side of the argument, it is evident that with the improvements that have been introduced of late, radio will become an important rival to the wire lines. This expansion will require operators which can only be obtained in sufficient numbers from the ranks of the amateurs. It is a fact that our best commercial operators today were formerly amateurs.

Then the shipping trade resulting from the war is going to be materially increased and every ship will require one or two operators. There are many former wireless "bugs" that with a little brushing up on their amateur practice could fill any of these positions. So it would be much better to give these men a chance than to fill these positions with so-called operators picked up hit and miss regardless of their qualifications.

There is yet another phase to the question. Radio makes an interesting diversion for the high school boys. Not only do they get many hours of interesting play out of wireless experimenting, but the technical education they thus obtain is of inestimable value. Every amateur must have an inkling of the theory of radio which of course, involves a knowledge of electricity. Other branches of electrical work offers many opportunities to young men, so that even if the amateur never intends to follow wireless as a profession, he has secured a store of electrical knowledge which would serve him equally well in many other lines.

Any one of these reasons alone would justify the government to lift the ban on amateur stations and to reissue licenses, which I believe will be done as soon as a permanent peace becomes more certain and the pressure of other measures allows the question to be acted upon.

In respect to power input, one kilowatt is sufficient, but stations should be allowed to use a longer wave length. The primary reason why they were before limited to so short a wave length was to eliminate interference with commercial stations that were working on slightly longer wave lengths. Nearly all the newly constructed commercial stations are operating on long wave lengths and it must follow that all stations will change to the longer wave. This should allow the amateur to use at least 600 meters because a 1 kw. station will work most efficiently between 400 and 600 meters.

Pvt. Homer G. Jordan—*A. E. F. Germany.*

For Those Who Sent the "Age" Overseas

To the Editor:—Many, many thanks for printing my letter requesting recent issues of The Wireless Age. I was surely remembered by many of the old boys and received over 20 copies, which I sent to radio men over here. I wish I was a writer; I would surely give you a lot of dope on how wireless was used in the war. I have studied all methods of communication. I have seen how the English, French and the Germans do it. I even tried hooking an aerial, consisting of six wires, to the balloon basket 2,000 feet high. No, don't laugh! It got results. The cable from the balloon to the winch makes a wonderful aerial.

It was great to hear all the broad wave sets in a sector. Talk about the amateurs on a busy night! They had nothing on this. You see, every company has a small transmitting set such as the S.C.R. 54. It has a broad wave and when about 30 of these get agoing, you know what happens. . . . Get my drift?

Wishing big success to the best radio magazine in the world—The Wireless Age—I am,

Joseph E. Engstrom (2 A. S. O.)
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Marconi and Fleming Support British Amateurs

MARCONI, inventor of wireless has again proved himself the amateur's friend. In the Wireless World, of London, appear his opposition views to proposed legislation in Great Britain which would prevent amateurs experimenting with wireless telegraphy. "I wish to state that, in my opinion, to follow such a course would be a mistaken policy," says Mr. Marconi. "It should be borne in mind that in many or, perhaps, in all branches of radiotelegraphy finality has by no means been reached, and I consider that the existence of a body of independent and often enthusiastic amateurs constitutes a valuable asset towards the further development of wireless telegraphy. It is wise also to remember that had it not been for amateurs wireless telegraphy as a great world-fact might not have existed at all. In the United States, for example, a great deal of the development and progress of wireless telegraphy is due to the efforts of amateurs.

"I think, therefore, that the suppression of the work of those amateurs who are interested in wireless telegraphy would be against the public interest."

Dr. J. A. Fleming, inventor of the famous Fleming valve, also makes a strong plea for the amateur:

"Now that the war is happily ended we ought as soon as possible to be freed from certain shackles of bureaucratic control and from any restrictions which were essential for national safety during the progress of the struggle. One of these is the permission under license to conduct research in radiotelegraphy and telephony. At the outbreak of the war all private and university radio stations were dismantled and non-official research stopped. The question then arises—how soon will these restrictions be removed? It is a matter of common knowledge that a large part of the important inventions in connection with wireless telegraphy have been the result of amateur work and private research, and not the outcome of official brains or the handiwork of military or naval men. In fact we may say that wireless telegraphy itself in its inception was an amateur product. At the time when Senatore Marconi first made known his epoch-making inventions the official telegraphists of the General Post Office had been working for years and spending large sums of public money in trying to develop and exploit the magnetic-induction and earth-conduction methods of wireless telegraphy of very limited application, but, apart from certain pioneer work by Admiral Sir Henry Jackson, they did not succeed in utilizing electro-magnetic waves for this purpose until Mr. Marconi showed them how to do it.

"Then, again, numerous important inventions such as the crystal detectors, the oscillation valve, the three-electrode valve, the electric arc generator, the high-frequency alternator-directive radiotelegraphy, beat reception, all the important uses of the thermionic detector, and much work on the study of atmospheric stray waves, has been due to private or amateur expert work, and not to official electricians in the General Post Office or the Army or Navy. If, then, full opportunities for such non-official work and research are not soon restored, there is no question that the progress of the art of radiotelegraphy and telephony will be greatly hindered.

"In an article published by me just eighteen years ago in The Nineteenth Century and After (February, 1901) entitled 'Official Obstruction of Electrical Progress,' I pointed out how much of all electrical discovery and invention has been due to amateur work, including in that term teachers and private investigators of all kinds.

"The action of Government officials has been in most cases to hinder and not help progress. As a rule the most effective method of afflicting any department of applied science with lethargy is to constitute it a Government monopoly."

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Queries Answered

Answers will be given in this department to questions of subscribers, covering the full range of wireless subjects, but only those which relate to the technical phases of the art and which are of general interest to readers will be published here. The subscriber's name and address must be given in all letters and only one side of the paper written on; where diagrams are necessary they must be on a separate sheet and drawn with India ink. Not more than five questions of one reader can be answered in the same issue. To receive attention these rules must be rigidly observed.

Positively no Questions Answered by Mail.

R. R., Wapinitia, Ore.:

Ques. (1)—Which is the most efficient, an open core transformer or a closed core transformer, both having the same power input?

Ans. (1)—If properly designed, they are equally efficient, but the open core transformer is more expensive to construct, because it requires more material than the closed core transformer for a given power input.

Ques. (2)—What would be the wave length of an 8 wire antenna, 60 feet in length, 38 feet in height at one end and 43 feet in height at the other end?

Ans. (2)—Approximately 135 meters.

A. P., Winthrop, Mass.:

The first receiving set you describe has a range of wave lengths up to 2,000 meters, the second set will respond up to 3,500 meters and the third set up to wave lengths between 6,000 and 8,000 meters. You will require loading inductances in the primary and secondary circuits of the second set to receive the longer wave lengths radiated by high power stations. It is difficult to conjecture your receiving range unless we know the type of oscillation detector you employ.

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H. R., St. Augustine, Fla.:

If you can procure a vibrator that can handle the primary currents of four induction coils, we would suggest that the primaries be connected in parallel, making sure that the current for all four coils passes through the vibrator. The secondaries may be connected in series or in parallel, depending upon the condenser capacity employed.

* * *

A. W. J., Warren, Pa.:

Pages 281 and 282 of the text-book "Practical Wireless Telegraphy," give complete dimensions of a long wave receiving set. The dimensions of the regenerative coupler are approximately those used for a 3,000 meter tuner, that is, the secondary coil may be about 5½ inches in length, 4 inches in diameter wound with No. 26 S. S. C. wire and the primary of similar length, but about 3½ inches in diameter wound with No. 26 S. S. C. wire.

The variometer type of coupler described in your third query will respond to wave lengths up to 700 meters.

The variometer mentioned in the first query should be wound with No. 28 wire in order that the tuner may respond to 3,000 meters.

* * *

C. F., Jersey City, N. J.:

The correct number of plates for the condenser mentioned is best determined by experiment. For one thing, inasmuch as you do not intend to place glass between the conducting plates, you will have to space the plates sufficiently to prevent the transformer discharging between them. With a 20,000 volt transformer, two banks in series are required. The capacity should not exceed .008 mfd. and a dozen of the plates you mention connected in parallel with two sets in series should give the proper capacity.

* * *

C. K. U., Ancaster, Ont., Canada:

If the receiving station to which you intend to transmit possesses a thoroughly sensitive oscillation detector, you should have no difficulty in covering a range of 10 miles with a 2-inch or 3-inch spark coil.

The poles to support the antenna need not be more than 30 feet in height. They should be spaced about 100 feet. Four copper wires spaced 2½ feet apart will be satisfactory for the flat top portion of the antenna. Either hard drawn or stranded copper wire may be employed.

The lead-in wire does not necessarily have to be placed in a vertical position, but it should be run as directly as possible to the station house. A complete transmitting and receiving apparatus to cover the distances you require should not cost more than $20 to $25.

* * *

J. A. B., Annapolis, Md.:

The filament current of various types of vacuum tubes varies with the construction. Some tubes require an ampere or an ampere and a half, while others will operate with ¼ or ½ ampere in the filament circuit.

Replying to your second query, the inductances in the X circuit of the Weagant receiver employs the same size wire used in the secondary circuit, although it is not strictly essential that the same size wire be employed.

Regarding the control of the plate voltage in the vacuum tube detector: To prolong the life of the plate battery, the most satisfactory method of controlling the voltage is to connect the cells to a multi-point switch varying the applied E.M.F. by a cell at a time. Either a series resistance or a shunt resistance may be employed. The shunt resistance should be approximately 3,000 ohms while the series resistance may have to be considerably greater, depending upon the internal resistance of the tube. Most amateurs prefer the cell by cell adjustment of the plate voltage.

C. B., Union, Ore.:

Any of the advertisers in THE WIRELESS AGE can supply you with raw material for constructing a wireless transmitter and receiver. Various types of cabinet receivers have been described in past issues of THE WIRELESS AGE. The set designed by Fearing Pratt in the April issue of the WIRELESS AGE consists of three receiving sets and you can select the one most suited for reception in your district.

The text-book "How to Conduct a Radio Club" gives dimensions of receiving tuners for various ranges of wave length. The dimensions of the coupler depend upon the wave lengths you intend to receive.

* * *

D. C., Ann Arbor, Mich.:

We presume that station licenses will be issued to amateurs just as soon as peace articles are signed. Experimenters are now permitted to operate their receiving sets, but they cannot use their transmitters until the ban is lifted.

* * *

F. S. F., Chicago, Ill.:

In a forthcoming issue of THE WIRELESS AGE, there will appear a complete description of a vacuum tube transmitting and receiving set which employs one bulb for both purposes. Dimensions and other data for construction will be given.

STATEMENT OF THE OWNERSHIP, MANAGEMENT, CIRCULATION, ETC., REQUIRED BY THE ACT OF CONGRESS OF AUGUST 24, 1912.

Of THE WIRELESS AGE, published monthly at New York, N. Y., for April 1, 1919.

State of New York, } ss.
County of New York. }

Before me, a Notary Public in and for the State and county aforesaid, personally appeared E. J. Nally, who, having been duly sworn according to law, deposes and says that he is the President of the Wireless Press, Inc., publisher of THE WIRELESS AGE, and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management, etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, embodied in section 443, Postal Laws and Regulations, to wit:

1. That the names and addresses of the publisher, editor, managing editor, and business managers are:

Publisher, Wireless Press, Inc., 25 Elm St., New York, N. Y.

Editor, J. Andrew White, 25 Elm St., New York, N. Y.

Managing Editor, None.

Business Manager, Alonzo Fogal, Jr., 25 Elm St., New York, N. Y.

2. That the owners are: (Give names and addresses of individual owners, or, if a corporation, give its name and the names and addresses of stockholders owning or holding 1 per cent or more of the total amount of stock.)

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3. That the known bondholders, mortgagees, and other security holders owning or holding 1 per cent or more of total amount of bonds, mortgages, or other securities are: (If there are none, so state.)

None.

4. That the two paragraphs next above, giving the names of the owners, stockholders, and security holders, if any, contain not only the list of stockholders and security holders as they appear upon the books of the company but also, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting, is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner; and this affiant has no reason to believe that any other person, association, or corporation has any interest direct or indirect in the said stock, bonds, or other securities than as so stated by him.

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President.

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(Seal.) M. H. PAYNE.
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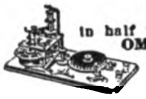

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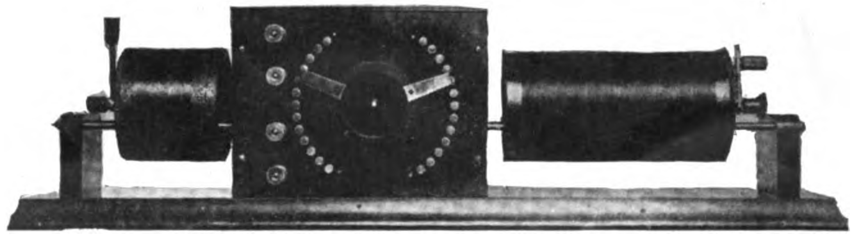

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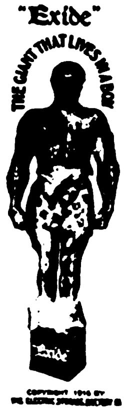
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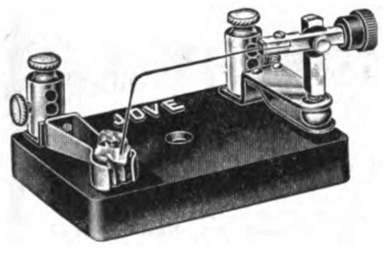

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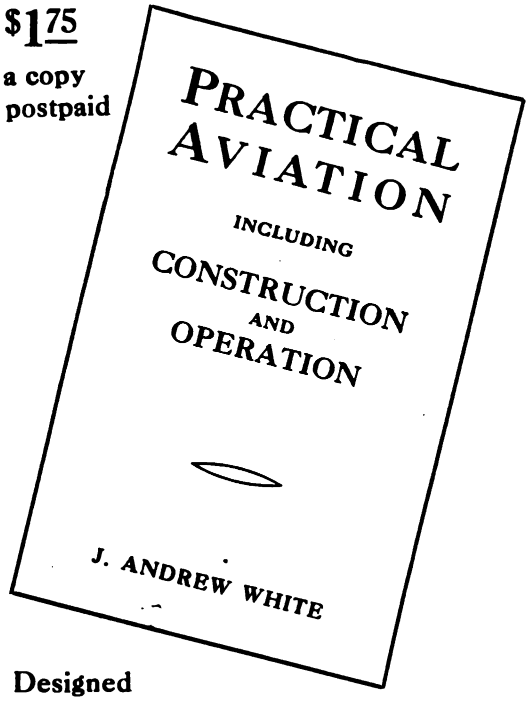

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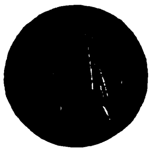

Medal and Diploma received at World's Columbian Exposition, Chicago, 1893

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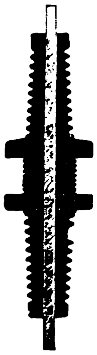

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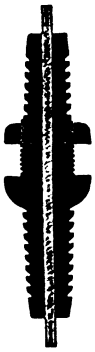

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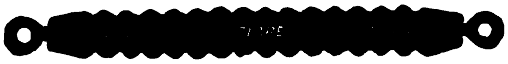

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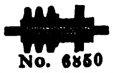

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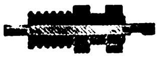

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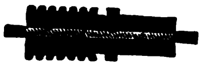

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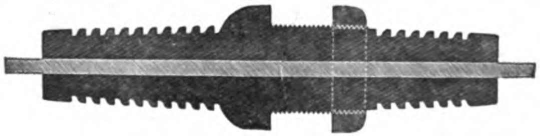

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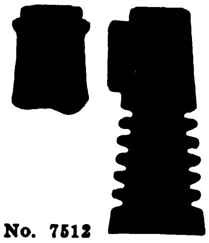

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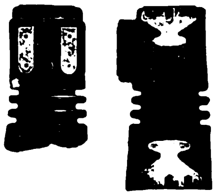

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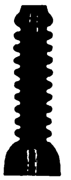

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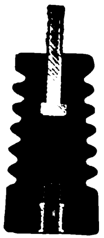

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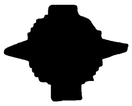

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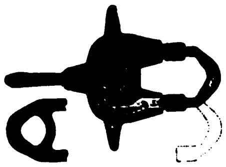

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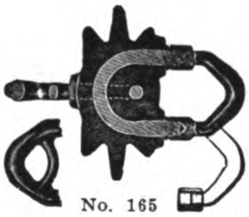

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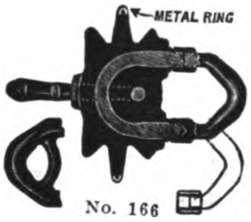

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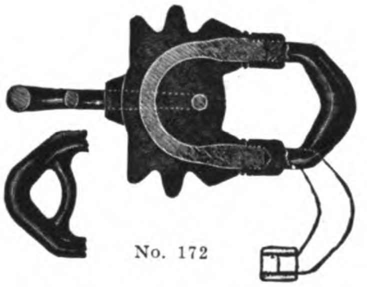

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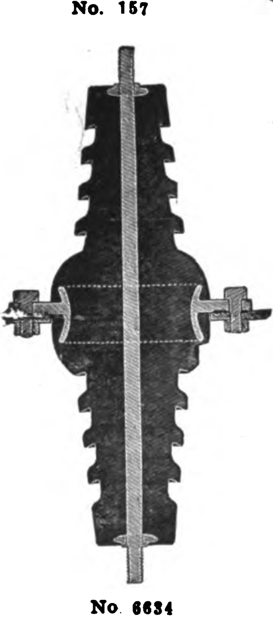

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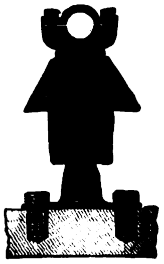

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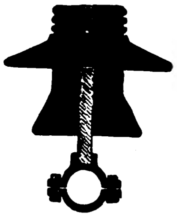

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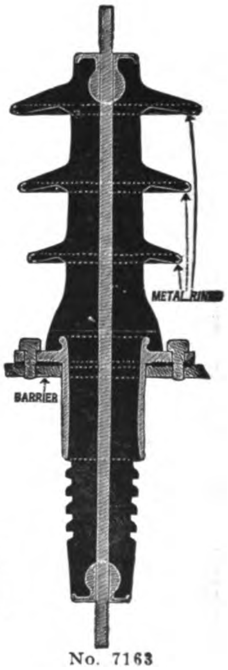

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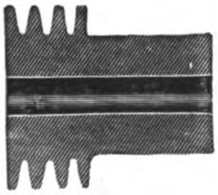

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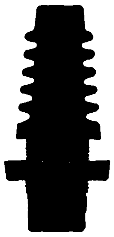

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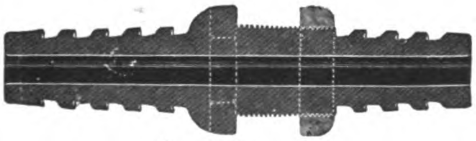

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The Wireless Age

Edited by J. ANDREW WHITE E. E. BUCHER, Technical Editor

Vol. 6 No. 9

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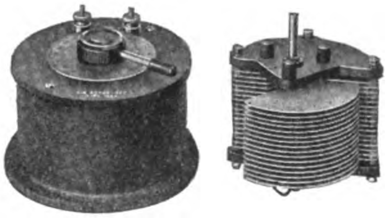

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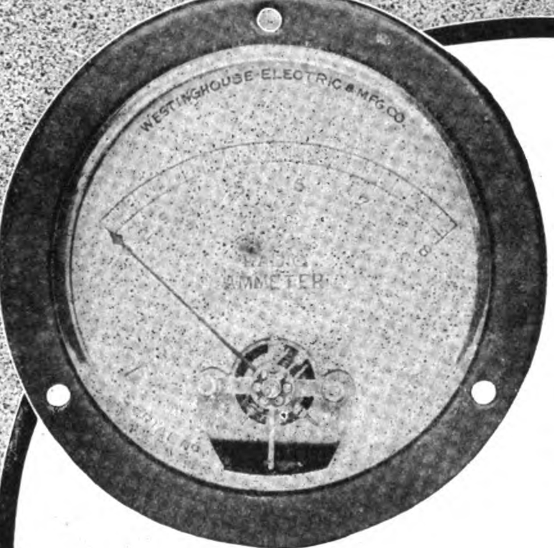

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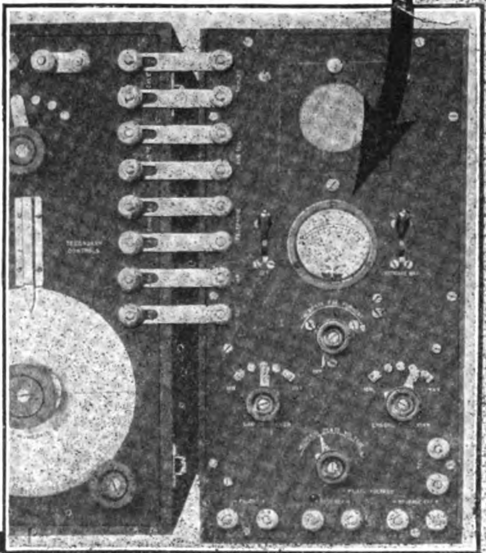

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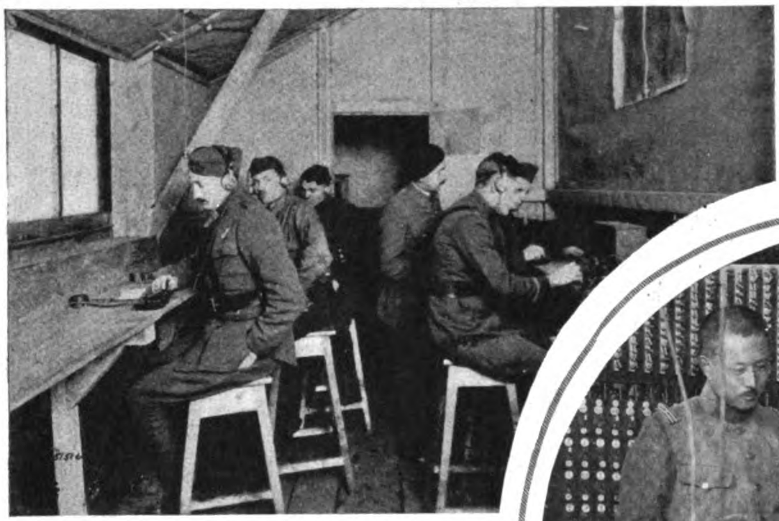
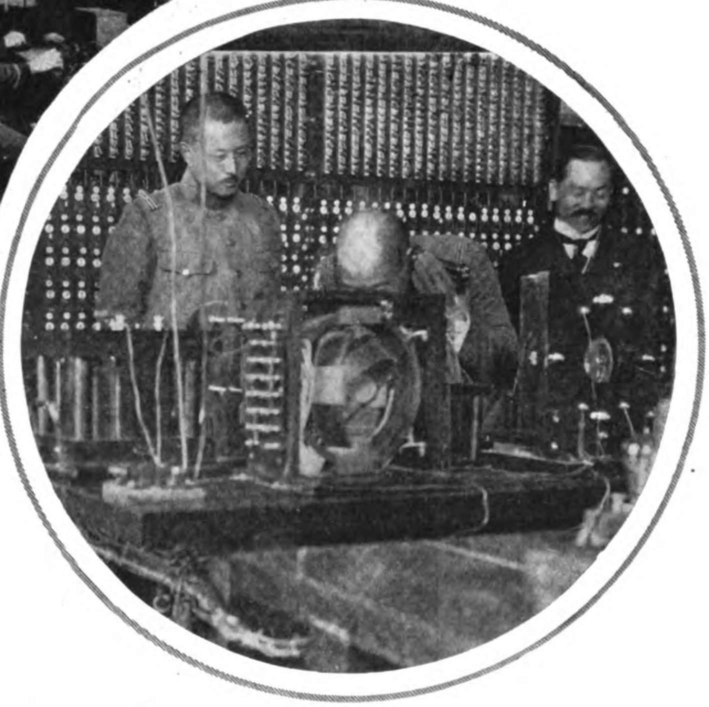


A group of observers at Le Valdahon, Doubs, France, getting in some wireless practice during spare time; novices are thus taught to send and receive, and experienced operators increase their skill

U. S. Official Photo



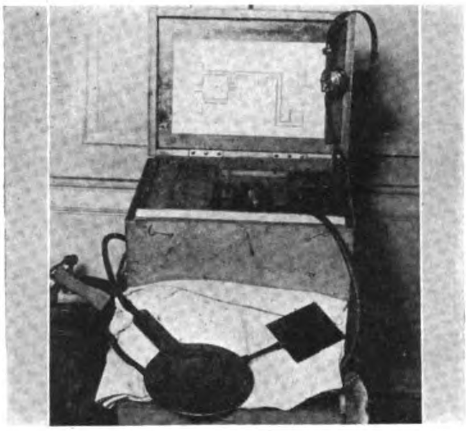
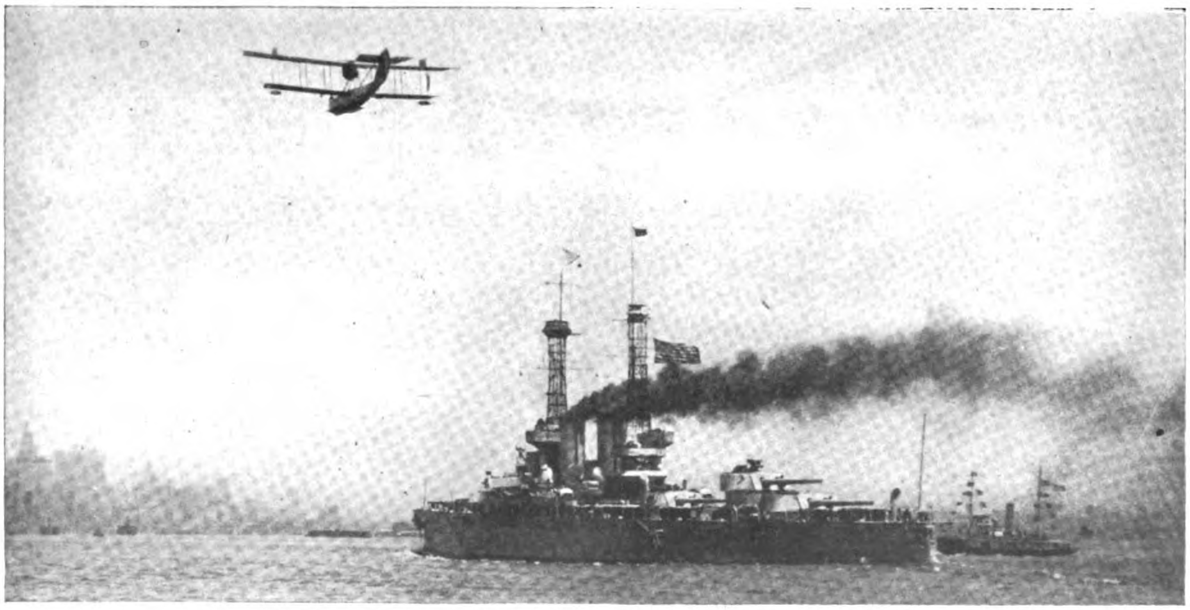


Photo: Press Ill. Svce.

In uniform, standing, in the circle above is H. I. H., Prince Kita-Shirakawa inspecting the wireless apparatus at Tokyo Central Telegraph office, as a complimentary message is being received from Guam

To the left is the hydrophone submarine detector used successfully during the war as a means of detecting the approach of enemy undersea craft



As the homecoming fleet sailed into New York an invitation from the reception committee was transmitted and the plans were approved and accepted by wireless

Photo: Press Ill. Svce.

Vol. 6. No. 9. June, 1919

THE WIRELESS AGE

WORLD WIDE WIRELESS

Growing Importance of Wireless Recognized

THAT the future for wireless is great and a belief that it will play a large part in reconstruction are thoughts expressed in a recent copyrighted dispatch from London to the N. Y. Sun. According to the writer, in a discussion of wireless and reconstruction Guglielmo Marconi noted that the war had done wonders for wireless. Never have so many kindred inventions been made in so brief a period as have sprung up in connection with wireless since the war started. As indicated by the fact that a message recently was sent half around the globe, wireless will have a tremendous role to play in the days of reconstruction.

Only those who know the cost of maintaining a line of telegraph across the wastes of the desert, through the jungle, across the wilds of the tropics, can have any appreciable idea of the saving that wireless will effect.

Tornadoes, even the ants, work havoc among telegraph wires. That this evil will be largely surmounted by wireless goes without saying.

Wireless will have a far greater part to play in connection with the great aerial routes with which the continents are to be linked up.

Wireless will have opportunity to display its powers in linking up those parts of the country intersected by waterways. The money spent in laying cables, in defraying the expense of upkeep and so forth, is amazing.

One thing upon which Marconi lays stress is the part his invention will play in fostering international relationships. He is profoundly grateful for what wireless achieved in the cause of freedom during the war, just as he rejoices over the thousands of lives saved by his invention before the war, to say nothing of the many rescued during the hostilities.

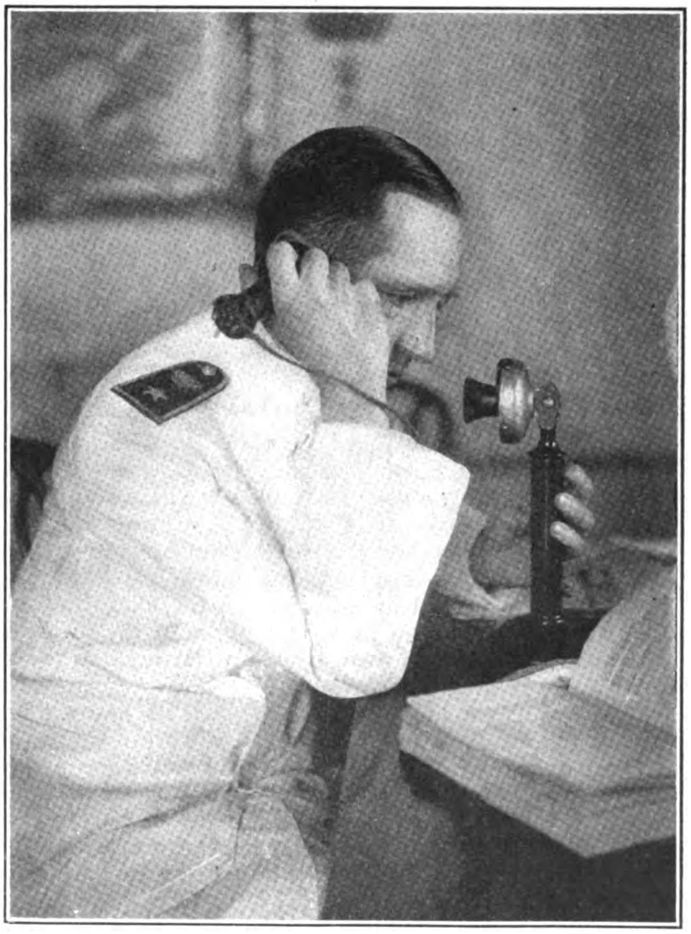
But the part it is to play during the day to be will best accentuate the utility of the invention of Marconi. Shipwreck will be a peril not half so terrible as it was till recent years. Opinions soon will be bandied about the earth in a way that seems incredible. Consultations between the world's statesmen, scientists, business heads, will constantly be in progress; the mountain ranges, the far-flung frontier line, the oceans, will be reduced into the compass of a few leagues.

The development of aircraft will be assisted by wireless in a way that baffles the imagination. Until recently an airplane or an airship enveloped in fog was more or less out of touch with the surface. Especially was this the case at sea, where many an able pilot came to a tragic end. But now lost in a cloud bank the aviator of today by wireless can be as certain of his bearings as if he were the skipper of a paddle steamer.

In the event of a great earthquake the wireless will be of even greater assistance than ever it was. In combination with aircraft, wireless would be the means of summoning assistance on such an occasion with startling promptitude.

And the same holds good in regard to railway collisions.

The telegraph has played the leading part in bringing many a criminal to justice. But an infinitely greater trap for the culprit will be the telegraphy which, independent of the innumerable restrictions of wires, can play a greater part in arresting his flight than telegraphers ever dreamed of.



Press Ill. Service

Recent portrait of Marconi, who sees great expansion in peace-time uses of wireless

German Peace Delegates Use Eiffel Tower Wireless

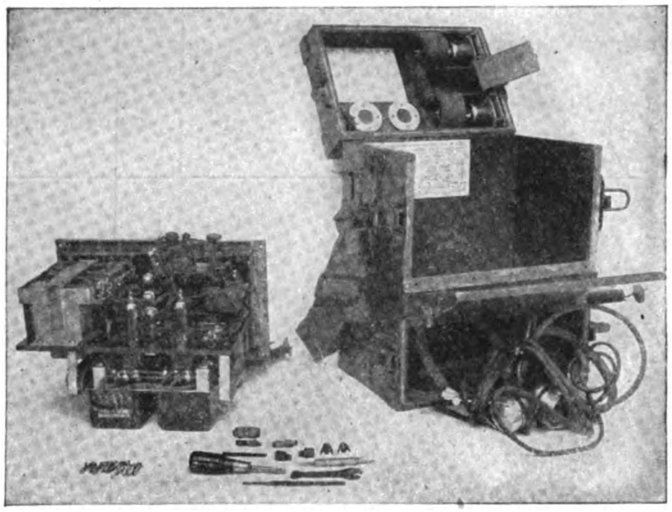
FOLLOWING the news of the presentation of the peace treaty it was stated that the high-power radio equipment in the Eiffel Tower had been reserved for the exclusive use of Count Brockdorff-Rantzau, head of the German peace delegation, at certain hours during the day. The announcement of this arrangement from Versailles added that a direct wire had been established from the Hotel Des Reservoirs to the famous French long-distance station.

International Commission to Distribute Radio Information for Aerial Navigation

THE proposed convention regarding international aerial navigation has been completed by the judicial and military sub-committees of the Aeronautic Commission of the Peace Conference, on which Brig.-Gen. Benjamin D. Foulois, Major Pollock and Capt. Bacon represent the United States.

The convention is composed of forty-one articles, which establish an international agreement on sovereignty of the air, provide for the concession of inoffensive voyages between the contracting states and deal with forbidden zones and also international aerial routes.

An international commission on aerial navigation is to be formed. Its duty will be the gathering and disseminating of radio-telegraphic, meteorological and medical information affecting aerial travel.



Ground telegraph transmitting and receiving apparatus

Voices By Radiophone Urge Purchase of Victory Notes

FROM an airplane flying 2,600 feet overhead an army officer read President Wilson's Victory Liberty Loan message to 15,000 persons assembled at the south steps of the Treasury, in Washington, by the use of the wireless telephone and a newly invented sound amplifier.

The throng of Government employees, dismissed for the capital's opening demonstration for the loan, cheered the President's message as spoken through the air and enunciated distinctly to them by Lieut. H. E. Metcalf, a radio officer in the airplane.

The "sound amplifier," was also given its first public demonstration in Victory Way, in New York.

The external evidences of the instrument were sound distributors, resembling phonograph horns in shape, suspended from wires over the heads of the crowds. The voice of a speaker given in at the central transmitter is amplified and carried with equal force to each of the sound distributors in the system.

Used in conjunction with the wireless telephone, sound was brought from a city wireless station and then reproduced over the overhead wires. Voices and phonograph and piano music were recorded.

Franklin D. Roosevelt, Assistant Secretary of the Navy, was one of those who spoke; his words were received by wireless telephone from Washington.

Visitors also had the official naval time transmitted to them every quarter hour in the same manner as the navy wireless station at Arlington flashes the correct time to ships at sea. Other features included the transmission of a soldier quartet singing at Camp Upton.

Overhead the big navy dirigible C-4 from the Rockaway station sent down a telephone message to the crowd to "buy Victory notes."

Wireless Warning Saved Leviathan from Floating Mine

THAT the transport Leviathan, biggest ship afloat, carrying 14,000 persons including troops, crew and civilians, came within ten yards of striking a mine on her way from Brest became known when the ship docked at Hoboken.

A wireless from the transport Mount Vernon on April 21st reported a floating mine 400 miles southeast of the Grand Banks. The Leviathan swerved southward, but at 10:30 o'clock the next morning her lookout reported a mine so close that when Lieut. Commander Harold Cunningham, the navigator, put the ship hard to port she missed the mine by only thirty feet.

◆

Naval Academy's Electrical Head Takes Charge of French Station

CAPTAIN A. St. Clair Smith, U. S. N., has been ordered from the Naval Academy at Annapolis to take command of the Lafayette Radio station conducted by the U. S. Navy at Croix d'Hins, near Bordeaux, France.

The station, which is nearly completed, has eight towers, each 850 feet in height. The control of the Croix d'Hins station, it is understood, ultimately will pass to France.

Captain Smith has headed the Department of Electrical Engineering and Physics at the academy for two and a half years.

◆

Croix de Guerre for Brooklyn Wireless Man

FOR maintaining his wireless station in the midst of the famous "million dollar barrage," Private Edgar T. Smith, of Brooklyn, has been awarded the Croix de Guerre. Smith was a wireless operator on a New York-Havana liner prior to enlisting May 4, 1917. He was assigned to the Signal Corps as an instructor in wireless signaling at Camp Upton. When the big drive started September 27, Private Smith was in charge of a wireless detail in the second line trenches of the Argonne. Six men were holding a station that invited shelling through the German's use of instruments locating wireless stations. As soon as the drive started and the wireless orders began snapping from the station the detail was located.

German guns were trained on the dugout where the detail was stationed and after a few close shots a direct hit knocked it to bits. Instead of going back the detail moved a half kilometer forward. Private Smith with three men established another station closer to the enemy guns. The other two men went out for food and Smith operated the station for 24 hours alone.

On February 27, at Ballou, the 37th Division, the Ohio National Guard, of which Smith was then a member, was reviewed and presentations of decorations made. With a kiss on each cheek he was given the Croix de Guerre for "distinguished bravery."

Smith was twice gassed and once wounded with shrapnel. He fought in the Vosges, St. Mihiel, Meuse-Argonne and other sectors.

◆

British Admiralty Removes Ship Radio Restrictions

ACCORDING to an announcement from the British Admiralty all restrictions on the use of wireless telegraphy on ships were removed on May 1st except in the North Sea, the English Channel east of the line joining Dungeness and Boulogne, in Baltic Northern Russia, in the waters of the Mediterranean, Black Sea, and Sea of Marmora.

Directional Effect of Radio Useful in Trans-Atlantic Aircraft Flight

PROFESSOR W. I. SLICHTER, of Columbia University, is the author of an interesting article which appeared recently in the New York World, dealing with one of the many cases where the development work in preparation for war may be put to permanent use in the arts of peace.

In transoceanic flight a difficulty will be encountered in that it is impossible to take an observation of the sun from an airplane, as is the universal custom among mariners in order to determine their position at sea. The reason for this difficulty is the mariner measures the angle between the sun and the horizon to determine his position, and the horizon is a definite thing to one located within a few feet of the level of the sea. But to an observer in an airplane the horizon changes with every change in altitude, and in order to make a careful calculation the observer would have to know his height above the sea very accurately and then make very complicated calculations.

That is why radio engineers are so interested in the problem of transoceanic flight; because they have a scheme by which the aviator may determine his position at any time of the day or night, in fog and cloudy weather as well as sunshine. In this it has an advantage over the present practice of the mariner.

To assist the transoceanic flyer it is necessary to have two or three powerful land radio stations, such as at Washington, D. C., Newfoundland, Ireland and France, send out signals of a definite strength at definite intervals, say once an hour. The operator in the airplane could by means of the well known directional effect of the radio direction finder determine the direction of any two of these stations and thus locate himself on the map by finding the intersection of two lines drawn in the proper direction from the two land stations. Two stations are all that are necessary theoretically, but as the plane might be travelling on the straight line connecting them, he would not always be able to tell his distance from his objective without a third.

It is to be hoped that in the two transatlantic flights about to be attempted in the very near future by an English aviator in one direction and an American navy aviator in the eastwardly direction this scheme will be tried. It is still in doubt, as radio engineers have not as yet attempted to reach great distances to airplanes.

◆

Patent Claim Is Basis for Injunction Against Alien Property Custodian

THE General Transmission Company, a New Jersey concern has brought suit in the equity courts to enjoin the Alien Property Custodian and the Secretary of the Navy from paying any money to the Atlantic Communication Company and the New York Patents Exploitation Corporation on account of the use of certain wireless apparatus by the government, the patent on which is said to belong to the General Transmission Company. An accounting is asked for.

◆

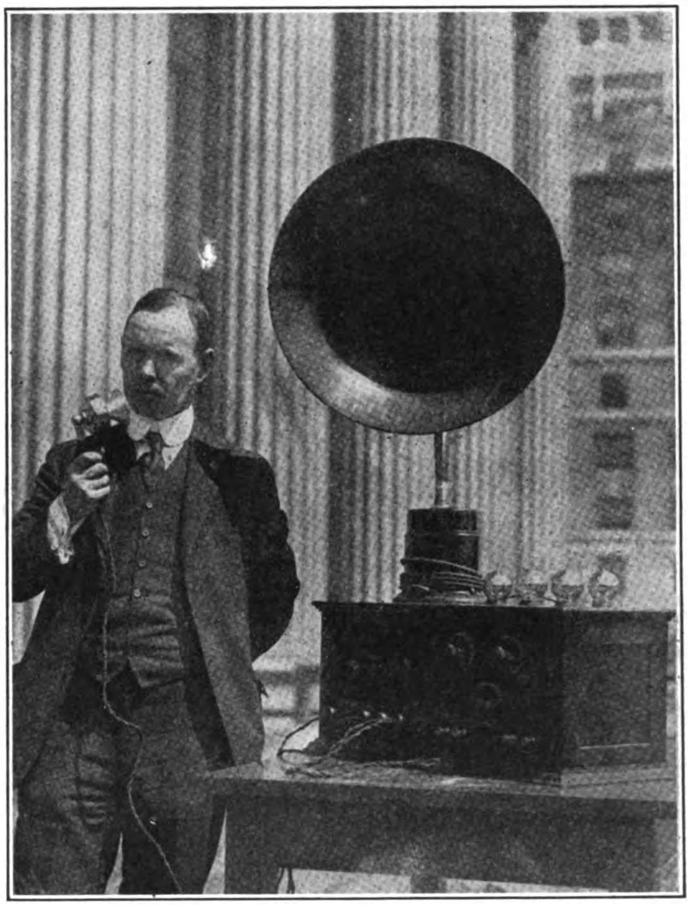
Hammond Wireless-Controlled Torpedo to Have Final Test

IT is announced from Washington that Colonel Robert S. Abernathy, a field artillery officer has been ordered to Boston as official representative of Secretary Baker, in connection with preparations for final tests of the wireless-controlled torpedo invented by John Hays Hammond, Jr., which Congress has authorized the War Department to take over if it fulfills expectations.

Selection of Site Made for Dutch Wireless Station

THE site for the wireless station intended for communication between the Netherlands and the Dutch East Indies has finally been decided. The selection made is the Koelberg hill, which is 86 meters high and located in Hoog-Buurlo, near Apeldoorn.

A new railway line will be constructed from Kaatwyk. The station is to have four towers, each 210 meters high, a large power house and building for housing the operatives. The communicating station in India is to be built near Bandoeng in the Preanger, so that the distance between the two stations will be some 11,000 kilometers.



Int'l Film Service

The "Magnavox"—meaning great voice—a device for amplifying wireless telephone speech

Engineers Believe Commercial Radio Telephony Offers No Complications

THE belief that radio telephony will be established commercially as a complement to the wire systems by means of which remote and inaccessible points may be reached, was expressed in a paper prepared by E. B. Craft and E. H. Colpitts of the Western Electric Company, and read at the convention of the American Institute of Electrical Engineers.

The paper described the work accomplished in the development of wireless telephony in the war, and called attention to its advantages and disadvantages as compared with the wire system. One of the principal advantages is that the wireless system would require neither fixed nor accessible channels, and no cost at all for line construction and maintenance.

"It is easy to see," the paper said, "that radio telephony could never compete with wire telephony in densely populated districts, while wire telephony is a physical impossibility at sea and in the air. Connection of a wire system to a radio system is no more complicated than connecting wire lines and therefore these two fields, although distinct, are adjacent."

Harvard Naval Radio School Comes to an End

THE naval radio school established at Harvard University during the war has been closed and the personnel and equipment transferred to the school at the Great Lakes naval training station.

Orders have been published detaching Commander David A. Weaver from duty at the Harvard school and assigning him to the Great Lakes station.

Wireless Service to West Indies Opened

THE Naval Communication Service has opened commercial traffic between St. Thomas, St. Croix, San Juan, Santo Domingo and Port-au-Prince and the United States via the Naval Radio Station at Guantanamo and cable from Guantanamo to the United States. Traffic will be accepted in the United States for West Indian points.

Direction Finder Locates Ship with Great Accuracy

ONE of the best records yet made by radio direction finding stations on the Atlantic coast was hung up by the Hog Island and Cape Henry stations on April 7th when they located the battleship Virginia, inbound with returning troops, several hundred miles off the coast, their estimate being within a mile of the ship's actual position.

According to the navigating officer of the Virginia the big battleship was plowing along through a dense fog, and no bearings had been taken for some time. Then the radio began to click and Cape Henry's position was located. A few minutes later Hog Island broke in and its direction was noted. Then a line drawn on a chart from Hog Island until it met a similar line drawn from Cape Henry pointed to the ship's location. Bearings taken a few minutes later proved the radio had come within a mile of the Virginia's actual position.

The officers of the Virginia, who have had considerable experience with the radio finding plants on the European side were amazed at the accuracy with which Cape Henry and Hog Island located the big transport.

Scene of Early Morse Experiments Now Has Wireless

WITH the installation of powerful U. S. wireless equipment at San Juan for transoceanic service, Porto Ricans are recalling that the electric telegraph had its first tryout in Porto Rico. Morse, the inventor, conducted many of his experiments at Cuatro Calles, in Arroyo. The terminals of his experimental line were the house he occupied and a warehouse in the same village.

Signal Corps Calls for Radio Men

THE Signal Corps, U. S. Army, is urgently in need of radio operators, according to the statement issued simultaneously from various recruiting headquarters. Cable and telegraph operators, telephone and telegraph line men, pigeon fanciers, and a number of other specialists are also required. The men are needed for Alaska, Philippine Islands, Panama, Hawaii, and for service in the United States.

All Canadian Amateur Restrictions Removed

FROM Ottawa, Canada, on May 5th came the long awaited news that the war-time regulations canceling all licenses issued for the operation of amateur wireless stations throughout the Dominion, have been rescinded. This decree frees experimental stations which have been inoperative for more than four and a half years.

Full Scope of German War Plotters' Radio Work Exposed

FRANCIS P. GARVAN, recently appointed Custodian of Enemy Alien Property to succeed A. Mitchell Palmer, designated by President Wilson for United States Attorney General, has made public the latter's report on the work of the office since America entered the war.

Of the wireless seizures, the report says:

It must have been apparent to the Germans that communication with America would be cut upon England's entry into the war, unless some means independent of cable or ship was established.

The war plotters found in a transatlantic wireless station the sole means of overcoming the British control of the seas and of maintaining their touch with America, and from 1910 to 1914 there were begun and completed two high-powered wireless plants, one at Sayville, L. I., and the other at Tuckerton, N. J.

Investigation of the wireless field disclosed that the Telefunken system had been installed on German shipping and on our own coastwise fleets, and had been operating with great success in conjunction with the Sayville plant. German stations had been installed in Cuba, Mexico, Central and South America. A high-powered plant had been erected at Togu, Africa, and China and Dutch East Indies and also the Pacific Islands had been sprinkled with Telefunken ship-to-shore stations.

An American appearance had been given to Telefunken in America by the organization of the Atlantic Communication Company and the naming of a directorate of American citizens. The technical work, however, and the disbursement of moneys were in the hands of German agents. Telefunken engineers came over to install the plant and operate it.

Despite the immediate cutting of the German cables and despite Great Britain's vast preponderance on the sea, Germany was able, while a ship floated, to keep in touch with it, and was able to begin at once the effort to influence American opinion.

Navy Offers Training Course to Experienced Men

AN unusual opportunity is offered by the Navy Department at the radio school in Cambridge, Mass., to men between the ages of eighteen and twenty-five years, who have some knowledge of radio work and who are able to send or receive ten words a minute. Applicants for this course must pass a creditable examination in spelling and penmanship and must understand elementary arithmetic. The course covers a period of six months and the subjects taken up during the course are magnetism, static electricity, current electricity, electromagnetism, alternating current, generators and storage batteries, motors and motor control, radio power circuits, oscillatory circuits, spark transmitters, detectors, service receivers, audions, high frequency measurements, review and examination for specialization. The Navy is offering this course, including all the text books and appliances for practical training, free to young men who meet the requirements for enlistment in this school.

By an order of Rear Admiral Victor Blue of the bureau of navigation, commanding that 160 men be sent from the Atlantic fleet each week to the naval radio school at Cambridge, it is believed that the school will remain at its present location until late this summer. The school was originally scheduled for transfer to the Great Lakes station at Chicago, next April.

Those enrolled at Cambridge in the future will be regularly enlisted members of the navy and will replace operators in the reserves, now serving on United States merchant ships.

Overseas in the Marconi Service

By George H. Fischer, Jr.

> Sailor take care, Sailor beware.
> Many brave hearts are asleep in the deep.
> So take care, take care . . .

THE little phonograph down below in the gunners' quarters squeaked away. A group on the poop were playing "acey ducey." A crap game was in full sway amidships. Nowhere could be found a less worried bunch of sailors. Most of them just couldn't take this "daw-goned" war at all seriously. Time and again they had crossed the war zone without even seeing a "sub" . . . they reckoned that submarine stuff was all exaggerated anyhow.

But they didn't know they had a jinx with them this trip. A jinx that always worked two ways: brought the trouble, and escaped it, too. The jinx was me.

The author with machine gun on board the Westwego

From the time when Uncle Sam first rolled up his sleeves and entered the war until the day Germany collapsed, I never made a trip to sea without having something happen. Even on my very first trip through the war zone as an enemy of Germany a submarine threw a scare into us. On that occasion there were no torpedoes. The arrival of another ship upon the scene was responsible for that escape.

Now I was on another ship bound for France. It was on board the old Westwego that I had stowed my bag this time. She was a great ship to carry oil; but to carry men—well the men were the last consideration. The reserve coal bunker, aft and just alongside the engine room, had been converted into gunners' quarters. The heat of the month of August was added to that of the engine; the gunner's gloryhole could scarcely be termed a comfy spot. But there never was an American crew of gobs that could stay grouchy no matter what kind of a ship they were on. The usual merchant ship crew of square heads are always grouching. If they aren't they're sick. But all was harmony on our old crab as we nosed eastward through the summer sea.

On all sides were scattered the ships of our convoy: every allied nation was represented. Our consort was H.M.S. Roxborough. Each of the twenty-four vessels in the fleet was bearing a precious cargo to France to feed the machine that was slowly but surely overpowering the Hun. On the other side of the sea were a few hundred submarines. We had no illusions about their manifests; their cargo was a death-dealing one, to be used in an effort to cut off the ever increasing stream of supplies flowing to France. We knew the record. Sinking non-fighting ships without a moment's notice. Murdering crews in cold blood.

As we neared the war zone, radio warnings came in ever increasing numbers. I found an old chart of the North Atlantic and on it recorded the various submarine "position reports" as they were received. On the fourth day of September we were steering due east. Wireless reports received during the night had all been put down on the chart, each sub indicated by a dot. These dots now formed a semicircle, into the very centre of which we were headed. Land's End called the cruiser with a code message that afternoon, and an hour later we were headed west. This maneuver had us all puzzled, and only those on the cruiser knew the truth of the situation.

At noon the next day we once more headed east, and this time we were accompanied by eight large British destroyers which had came up at daybreak from the south'ard.

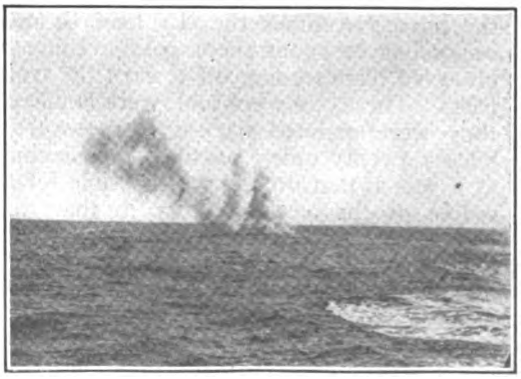
It was wonderful weather for a sea trip. The sea was dead calm and the air not too warm. The afternoon dragged away. The phonograph squeaked worse than ever, for the same needle was still doing duty. Eight bells of the afternoon watch clanked, and died away.

Suddenly, a dull boom sounded from across the water. The cruiser fired an answering shot. Then came a great explosion which shook the whole vessel. We were torpedoed! No; we were safe; it was the ship right off our quarter; the torpedo had passed under our stern.

"General Quarters!" The gunners crowded on the gun platforms eager for a shot at the attacking submarines. A periscope came up for a moment right astern, but our guns were silent; they could not be fired because of the risk of the shell ricochetting and striking a T.N.T. ship which was right behind us. Those of the crew not on watch crowded to the boats and made ready to let go. I was in the radio room and could see only aft, but what I saw was enough to occupy my entire attention. A tanker, the Messina I believe, had been hit in the forward section and was sinking very fast. The torpedo had torn away half her bow; she rose to a vertical position with her propeller churning the air; poised for an instant and then plunged beneath the waves. . . . Two little boats were left bobbing on the surface; many little black

Gun crew at drill. Machine gun in foreground

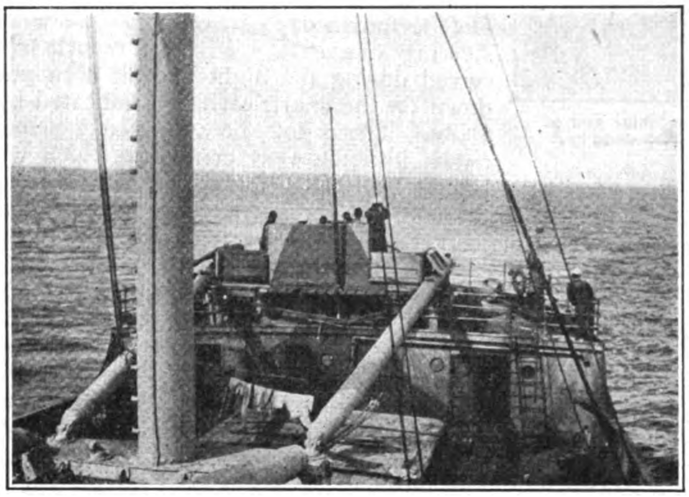
3-inch gun mounted on poop deck


Explosion of smoke producing bomb for smoke screen

specks scattered about reminded us that all had not had time to get to the boats. The very smallness of the struggling forms made the great expanse of water seem greater.

Off to the left was another sinking tanker. She was going down by the stern, not so quickly as the Messina. A destroyer dashed past us, headed for a spot of oil on the surface. Three "ashcans" went over her side. The first and second of these depth bombs brought up great columns of water, but the third must have struck home for the water came up black with oil and wreckage.

The official report said there had been six submarines in the attacking force, the first to make a massed attack. There was no confusion. I still do not know positively how many ships were sunk, but there wasn't a very great number in the fleet that proceeded up the channel. We sat up all through the night and drank coffee; it was lukewarm in the cups, but coffee in any form was acceptable to men from whose faces had faded the "I should worry" expression. In its place had appeared the tense fixedness of grim determination to square accounts with Fritz at the first opportunity.



Camouflaged gun platform and crew firing at target

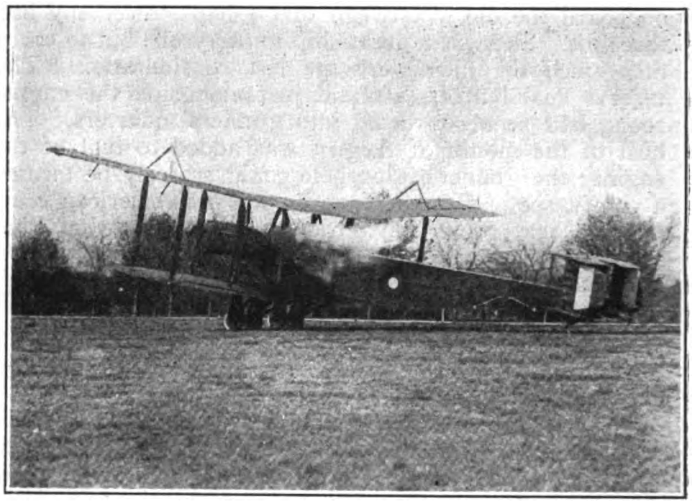
We arrived at Dunkerque, France, two days later, after a short stop-over at Folkstone. Events on our trip across had impressed us with a hatred for the Boche; but that which followed seared that hatred into our souls.

Dunkerque, the one time third port of France, we found a busy military centre. Its devastation lacked the completeness of towns further up the line, but ruined buildings everywhere reminded one that a war was being waged close by. There were two aviation bases at Dunkerque, one French and one English. Our cargo, fuel for the airplanes, was greatly needed. Aerial activity had been unusually great during the past week and frequent raids were taking place. I will endeavor to describe for you one of these raids as it appeared to a merchant mariner.

All day long airplanes had been going and coming from the north; at times the sky held so many that it was impossible to count them. As evening approached, we observed planes going off toward the front lines in small fleets. These, we were told, were bombers. Great giants they were, painted dark grey. As we were approximately twenty miles, possibly less, behind the battle line as it was at that time, it was possible for us to see considerable of the aerial activity in that direction. Along about five o'clock in the afternoon we noticed that a fleet of planes which had left Dunkerque shortly before was being shot at from the German side. Little white puffs of smoke were bursting all about them. Soon the aircraft became mere specks in the sky and we had to use glasses to follow them. Another group of specks—Germans—were seen to be mounting into the sky. In a few moments both groups met and an aerial battle was in progress. It was too far distant to be observed distinctly, but we felt the thrill of each daring maneuver and silently applauded each burst of machine gun fire.

Orders came for us to move. An air raid was expected and there was too much danger of the Westwego being blown up by a bomb from overhead. We were taken out for the night to an anchorage about a mile below the lighthouse. Near by were anchored two British monster monitors, just returned from bombarding the German positions on the Belgian coast. As luck would have it, part of our crew were on liberty and had been left ashore.

The night was mild and the sea dead calm. I was aft, taking an after supper prom on the poop, when we were startled by a dull "kerump!"—the queer and very distinctive sound an aerial torpedo makes when it explodes. We rushed to the other side of the ship and found the show in progress. Searchlight rays were sweeping back and forth across the skies like blades of grass waving in the breeze. Every few seconds there would be a red flash from the ground and the "kerump" which followed told that another bomb had reached its mark. The Germans were by now over the main section of the city and they began dropping flares. These flares were attached to parachutes and gave a very powerful illumination of 400,000 candlepower held suspended in the air, lighting the ground beneath to a circular area more than a mile in diameter. While the flares made it possible for the Hun fliers to observe the activities on the ground and ascertain the location of the important buildings, they also made it more difficult for the anti-aircraft gunners to locate them, as they flew above the lighted area. A barrage was put up all about the city by having the anti-aircraft guns fire shells into the air which were timed to burst at various heights. Each line of guns having a shell bursting at a greater height than the other before it, the air became filled with bursting shrapnel, thus forcing the Boche machines to a greater height than was favorable for their operations.



As evening approached we observed planes going off toward the front lines

Anyone who has ever heard a German airplane motor will be sure to remember its queer tone. It has a regular beat or throb to it instead of the purr that the allied engines have. A Canadian lieutenant at Dunkerque had told me how these Hun machines sounded and I recognized the tone immediately. Louder and louder came the "hum-ahum-ahum" till it was directly over our heads. All the lights aboard were out; we stood there in the darkness and gazed up and cursed. It is almost impossible to express the baffled feeling of rage when you are placed in a position where the enemy can fire on you and

Lights sprung up in the landing fields and the planes which had gone forth to give battle to the raiders came down

you can't fire back. It would have relieved the tension if we could have fired our machine gun, but unfortunately this had been stowed away on our arrival at Dunkerque.

Suddenly, the monitors to our port side began firing their anti-aircraft batteries. The shrapnel exploded with piercing crashes overhead and we ducked for cover to be out of the way of falling pieces, for the scattering fire is almost as dangerous coming down as it is going up. As we stood by, helpless and watching, I became conscious of a succession of sounds that had hitherto been meaningless. Then I realized that all during the noise, the German wireless station KBU could be plainly heard working by those amidships. The signals were audible fully eight or ten feet away from the radio cabin.

A move was made to launch a boat; then we were told to have it in readiness to lower. Our greatest danger lay from shrapnel or in a spark from a flare setting off the gasoline in our tanks. The captain appreciated this a moment later and ordered the boat back into the chocks, accompanying the order with the assurance that should the ship explode we'd need no boat to carry us into a different vicinity.

We were held in suspense through many minutes, each of which seemed hours long. The Germans swept across the city three or four times; then they passed on down the coast to Calais where they also gave a short performance, and returned to us. Machine guns and anti-aircrafts reopened fire, evidently without success. But a red glow had broken out over the northern section of the city, indicating that some of the bombs had taken effect.

After another hour or so the firing gradually ceased and the allied air scouts signaled with Morse lights that all was clear. Lights sprung up in the landing fields and the planes which had gone to give battle to the raiders came down.

I sat out on deck till near morning. All along the front the artillery was active. We could see the flashes and hear the booming of the big guns "up the line" as they pounded away all night. . . .

The next day the communique read: "All quiet on the western front."

Aircraft Maker to Have Wireless Equipped Automobile

WHEN it comes to the matter of equipment it is probable that Glenn Martin's new car is going to be the most completely equipped automobile that ever turned a wheel. The airplane manufacturer recently visited the Los Angeles Stearns-Knight headquarters and gave an order for a 1919 four-cylinder Stearns to be delivered to him at his Cleveland plant.

"It's going to have practically everything that an airplane has on it, including a combination wireless telephone and telegraph outfit," Martin said. "My work is divided between the flying fields and the factory, so that it is of extreme importance to me to be in touch with both places at all times, and it will be a marked convenience as well to be in communication with the aviators in their testing work in the air.

"At present, these wireless outfits cost $2,200, but I can foresee the time when they will not cost more than $500, and will be installed as optional equipment on many high-grade cars. They have a telephonic range of thirty miles, and the simple turning of a switch converts them into a wireless telegraph outfit with a range of 300 miles.

"A red light will flash on the dash of my car when someone wants to get in communication with me, and it will only be necessary to put the receiver to my ear to get the message, if I am within thirty miles of the man who wants to talk to me.

IN THE JULY ISSUE

The concluding instalment of Weagant's invention for eliminating static.

Don't miss this most important article!

Wireless Telephone Transmitter for Seaplanes

Flying Boat Type S. E. 1100, Developed by the American Marconi Company for Navy Use During the War

MARKED progress in the perfection of airplane wireless telegraph and telephone apparatus is a direct result of exhaustive researches in radio communication which have been conducted during the past two years. Light-weight transmitters having a sending range of 150 miles or more have been developed. Spark apparatus has been employed to a considerable extent in airplane communication, but transmitters utilizing the vacuum tube oscillator have the advantage of permitting either speech transmission or telegraphic signals by damped or undamped oscillations, at the will of the operator.

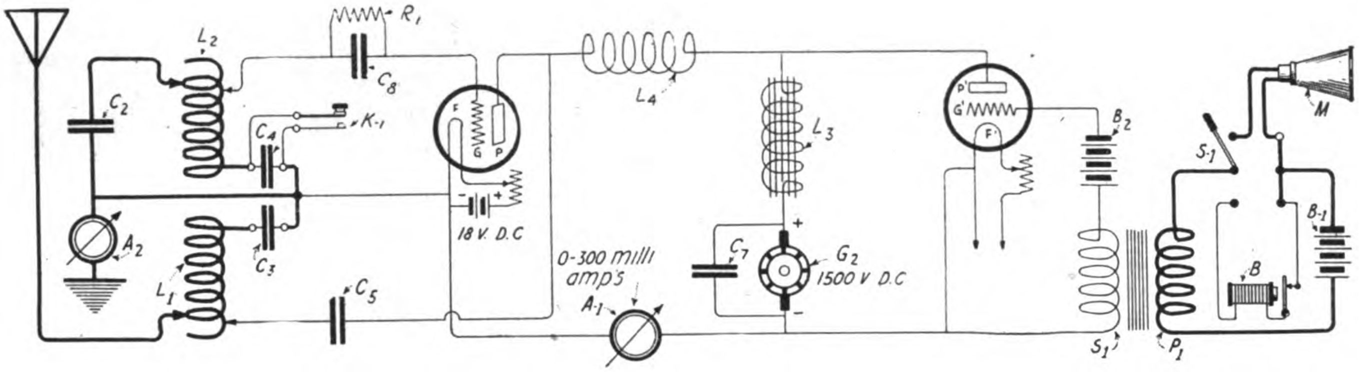


Figure 1—Fundamental circuits of the wireless telephone transmitter for seaplanes

Practical wireless telephone apparatus of the vacuum tube type is disclosed in the following description of the Marconi type S.E. 1100 set—a comparatively high power bulb transmitter—developed by the Marconi Wireless Telegraph Company of America.

The set was designed primarily for the large flying boats, the H-16 class, of the U. S. Navy, and has fully satisfied every test to which it has been put. In one of the earlier tests in flight over Chesapeake Bay, telegraph signals radiated from a trailing antenna on an H-16 boat were heard distinctly in Washington, D. C., over a distance of 120 nautical miles. Subsequent tests with the set used as a wireless telephone permitted the accurate transmission of speech over a distance of 150 miles. The transmitter radiates at two wave lengths, 1600 and 600 meters. For the former wave length a trailing wire antenna of .0004 mfd. is employed; for the latter, an emergency aerial of .00026 mfd.

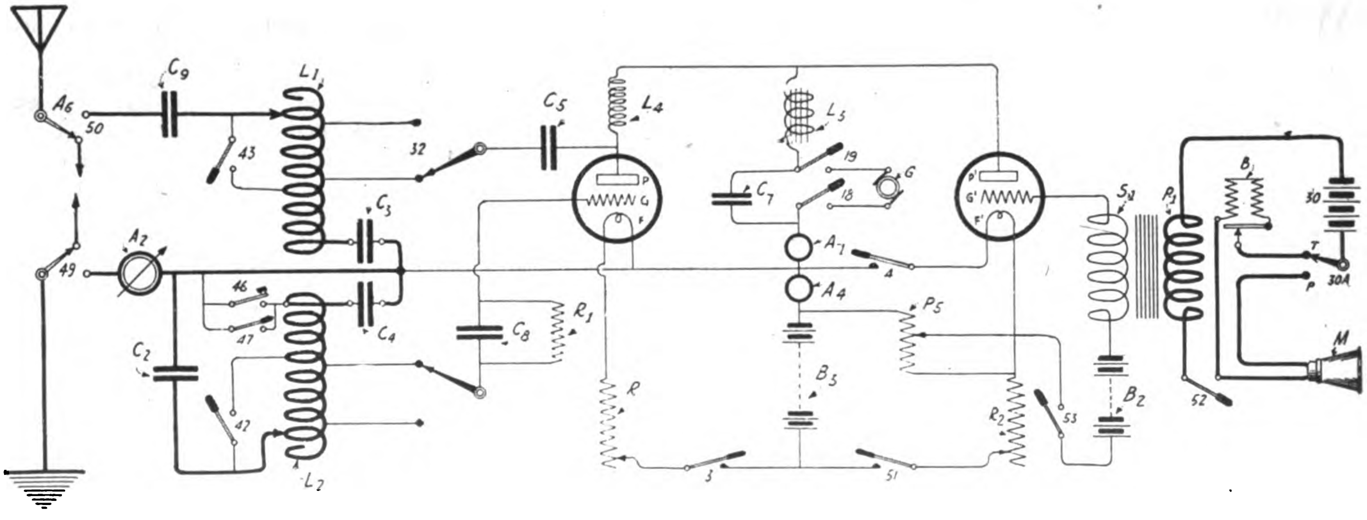


Figure 2—The actual circuit used in practice

The transmitter is supplied with two 3-electrode tubes of the pliotron type. One tube is employed as an oscillator for the production of radio frequency currents and the other as a modulator and amplifier of the voice currents communicated to it by the microphone.

The fundamental circuits of the set are shown in figure 1, the actual circuit in figure 2, a front view of the transmitter in figure 3, a rear view in figure 4, a side view in figure 5 and a wiring diagram showing the function of the change-over switches in figure 6. An installation sketch is shown in figure 7.

DESCRIPTION OF THE CIRCUITS

For best understanding of the operation of the apparatus, it should first be appreciated that if the grid and plate circuits of a vacuum tube include radio frequency circuits coupled inductively, conductively or electrostatically, alternating currents of any desired frequency may be generated. This is the first requisite;

other problems, such as rapid change of wave length, satisfactory modulation, and the elimination of disturbing capacities between circuits, arise in the practical set, and are of equal importance. They were satisfactorily solved only after diligent research.

In order to set valve circuits into a state of radio frequency oscillation, it is necessary that the connections be so made that the grid end of the grid inductance will be alternately negative and positive as the plate end of the plate inductance is positive and negative. When the grid and plate radio frequency circuits are coupled with the proper phase relation, any variation of voltage in either the grid or plate circuits will cause minute disturbances in the oscillation circuits, setting them into oscillation at whatever frequency they happen to be adjusted to. For example, a slight variation of voltage in the plate circuit by any means whatsoever, will cause its resonant circuit to oscillate at radio frequency, and the resultant currents will act upon the grid circuit, setting it into oscillation at the same frequency. The resulting radio frequency fluctuations of the grid potential will act upon the plate at the right time to keep the plate resonance circuit in a state of oscillation, and this state of affairs will continue so long as the proper supply of voltage and filament current is maintained, but not otherwise.

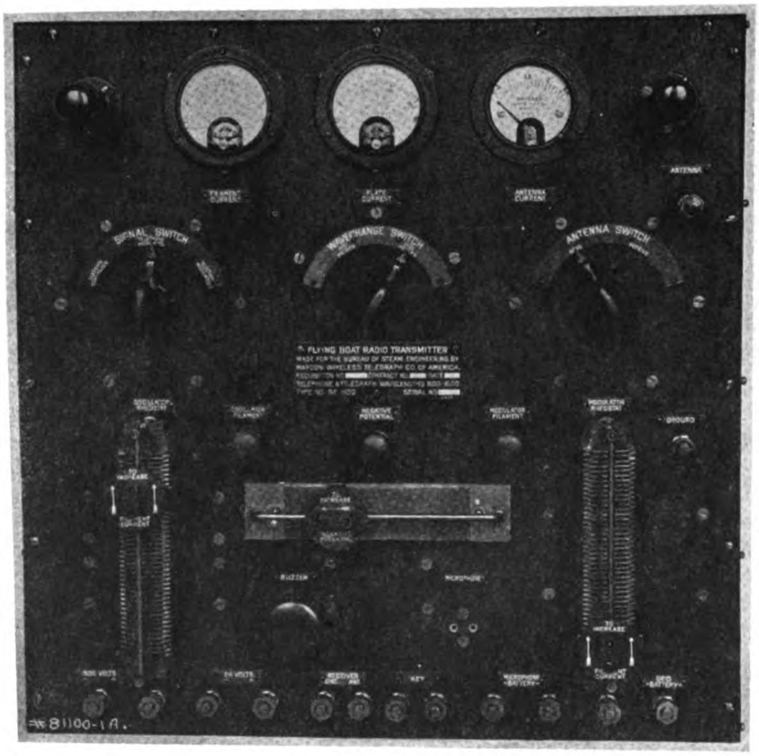


Figure 3—Front view of the Marconi wireless set, SE1100, used in flying boats

The tube is able to generate alternating currents because of its amplifying properties. The energy delivered to the grid circuit in accordance with the actions just outlined will gradually increase in value until a maximum is reached, which is the maximum output the valve is capable of delivering, as may be discerned from the well-known characteristic curve.

Referring to figure 1, it will be observed that the plate and grid circuits of the tube contain the coils L-1 and L-2, in inductive relation, each connected through the condensers C-3 and C-4 to the negative side of the filament. The grid oscillating circuit comprises the coil L-2, the condenser C-2 and a protective condenser C-4. The plate oscillating circuit includes the condenser C-3, a part of the coil L-1 and the series condenser C-5. The antenna and earth connections tapped off from the coil L-1 take the place of the condenser C-2 in the grid oscillating circuit. C-2 is called the balancing condenser. In series with the grid is another condenser C-8 shunted by a leak resistance R-1, which maintains the grid at a negative potential.

The system further includes a three electrode tube F′, G′, P′ which amplifies the output of the microphone circuit and simultaneously modulates the output currents of the oscillating bulb.

It will be noted that the plate circuit is fed by a 1500 volt DC generator G-2, the positive terminal of which connects to the plate P of the oscillating tube through the audio frequency inductance or transformer L-3 and the radio frequency inductance L-4. The negative side of the generator connects through the milli-ammeter A-1 to the negative side of the filament F. The condenser C-5 is the protective condenser which is generally employed in tube oscillating circuits when the source to the plate circuit is connected in shunt to the plate and to the filament, as is the case in this circuit. The modulating circuit shown to the right of the drawing permits either voice transmission or telegraphy by damped oscillations.

Circuits for Wireless Telephony

For telephony, the microphone M is placed in series with the telephone induction coil P-1, S-1, and the battery B-1, by means of the switch S-1. The coil S-1 is connected to the grid and filament of the modulating tube, and includes in its circuit the battery B-2 through which the grid is held at a suitable negative potential for maximum magnification. The filament and plate of the modulating tube are shunted across the plate circuit of the oscillating tube. The audio frequency choke L-1 may be said to act as a one to one transformer. The radio frequency choke L-4 prevents the radio frequency currents developed by the oscillator from flowing back to the plate circuit generator G. C-7 is a protective condenser for the plate circuit generator.

When the transmitter M is spoken into, speech currents of variable frequencies generated by the microphone are impressed upon the grid circuit of the modulating tube and, through the medium of the auto transformer L-3, alternating currents are superposed upon the plate circuit of the oscillator. This in turn varies the amplitude of the oscillator currents at speech frequencies, and accordingly the amplitude of the radio frequency oscillations flowing in the antenna circuit. It is essential that the key K-1 of figure 1 be closed for the production of undamped oscillations, for when it is open the tube stops oscillating. Manipulation of this key permits telegraphic signaling by the undamped oscillations produced by the tube.

Telegraphy by Damped Oscillations

When it is desired to telegraph by damped oscillations, the change over switch S-1 is thrown from the microphone to the buzzer B which is energized by the battery B-1. The interrupted currents fed by the buzzer through the primary P-1 of the induction coil produce alternating currents of higher voltages in the coil S-1, which in turn are magnified by the modulating tube, the latter varying the radio frequency currents in the oscillator tube at the frequency of the buzzer. In this way, the antenna radiates *damped oscillations* in groups, the frequency of the groups varying as the number of interruptions of the buzzer.

A more detailed circuit of the Marconi aircraft set appears in figure 2. This diagram not only embraces the fundamental connections of figure 1, but includes all necessary switches for the three different signaling func-

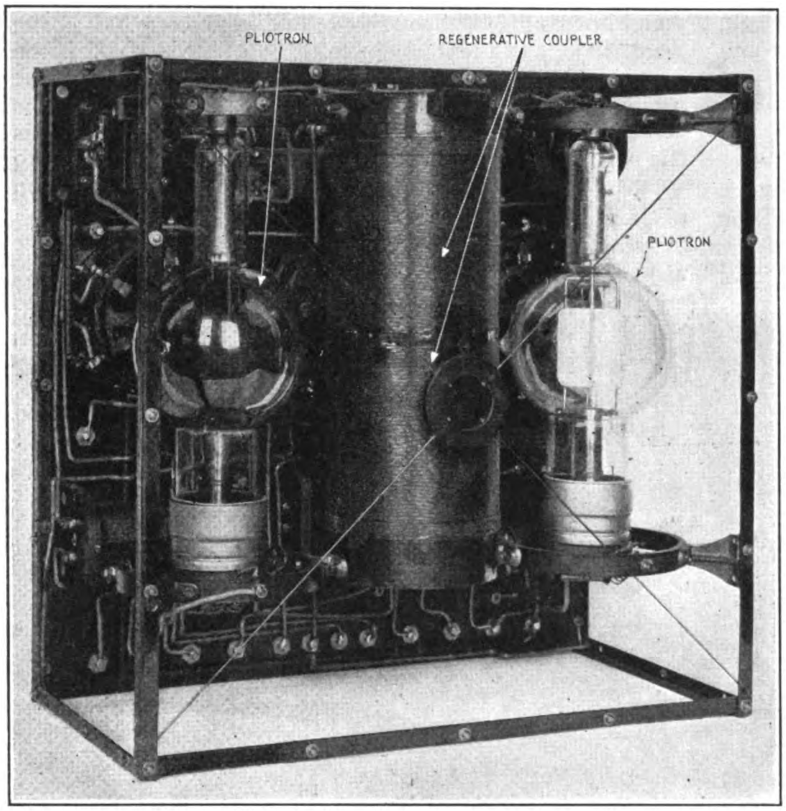


Figure 4—Rear view of the transmitting set with pliotrons in place

tions on the 600 and 1600 meter wave. It includes, moreover, a detailed wiring diagram of the filament circuits.

Details of the Filament Circuit

The filament circuit divides at the positive terminal of the 24 volt storage battery B-3, one branch going through the rheostat R-1 to the filament F of the oscillating valve, and the other going through the rheostat R-2 to the filament F' of the modulating valve. The negative sides of the two filaments are connected together and to ground. In addition there is provided a potentiometer P-5 connected across the battery B-3 with a tap leading to the negative potential battery B-2 and on through the secondary of the microphone transformer S-1 to the grid G'.

The object of the potentiometer in figure 2 is to compensate for any loss of negative potential in the grid circuit G', which may be occasioned by the lowering of the voltage of the filament battery B-1.

The switches for shifting the connections from one system of signaling to the other are enclosed in drums, as may be noticed in the left hand part of the photograph of figure 5. The schematic diagram of these is shown in figure 6. The inside and outside rows of jaws on each set are represented by the upper and lower group of dots in figure 6. In that figure the left hand pair constitute the *wave length changing switch,* the middle pair, the *sending and receiving switch* and the right hand pair, the *signal switch.* The first, second and third positions of each switch are indicated by the letters X, Y and Z, these letters being placed between the two points which the blades of the switch short circuit in that position.

Regarding the action of the oscillating valve itself: When the grid is negative in respect to the filament, no current passes between the grid and filament; but when it is positive, considerable current passes which constitutes a loss in the circuit; but if the grid is held at a constant negative potential this energy loss is reduced and a more effective transmitter is obtained. The grid potential may be held at a negative value by the insertion of a grid battery but it can be done in just as effective a way by inserting a condenser in the grid circuit which rectifies the grid currents and holds the grid at a negative potential.

If the leak were not provided, the potential of the grid would rise to such a high negative value that all action would be stopped. A leak of proper value definitely limits the maximum negative potential of the grid and therefore does away with the necessity for a special grid battery.

Change-Over Switches

The numbers on the separate single pole switches in figure 6 correspond with those shown in figure 2. The *outside row* of studs on the wave length changing switch perform the following functions: In the 600 meter position (X at 32 in figure 2) the first tap on the upper section of the loading coil L-1 is connected to the plate series condenser C-5, and at 43 short circuits the end portion of the same coil. In the 1600 meter position Y, it connects at 32 the second tap of the coil to the condenser and opens the short circuit.

The *inside row* of studs on the wave length changing switch performs the same functions for the coil L-2, which is the lower portion of the long single coil mounted in the middle of the rear of the panel in the accompanying photograph. In the schematic diagram, figure 6, the blade marked 35 is shown connecting to the first tap of the lower portion of the coil in the 600 meter position, and to the second tap in the 1600 meter position to the grid condenser C-8 with its leak resistance R-1. The actual wiring of the set differs slightly from this, for it was found that the same tap of the coil was correct for both wave lengths. For this reason, there are but two taps on the lower portion of the coil. The first of these is coupled

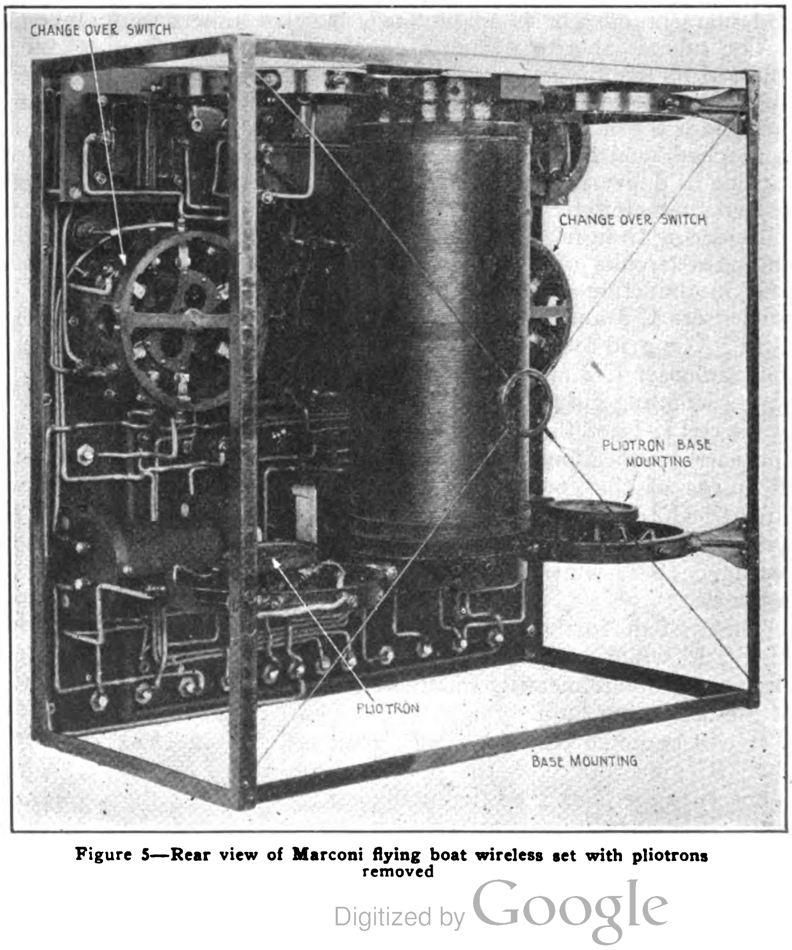


Figure 5—Rear view of Marconi flying boat wireless set with pliotrons removed

directly to the grid condenser C-8 and does not go through the wave length switch. The blade marked 42 short circuits one end of the coil L-2 in the 600 meter position and removes the short circuit in the 1,600 meter position.

The outside portion of the switch marked "send-receive" (in the right hand position of figure 3 and also in the upper central position of figure 6) serves to connect the antenna A-6 to the transmitter in the "send" position (X) and to the receiver in the "receive" position (Y). In the "send" position the circuit of the antenna at 50 is through the series condenser C-9 to the top of the loading coil L-1 and to the ground. The latter is connected at 49 through the antenna ammeter A-2 to the main ground bus of the set which is the frame.

The inside portion of the "send-receive" switch, in the lower part of figure 6, is idle in the receive position Y, but in the "send" position X at 21, it completes the 1500 volt DC supply current to the plates P and P-1 of the pliotrons. At 52 it connects the primary of the microphone transformer P-1 to the microphone terminals 28 and to the buzzer B. These connections are opened in the "receive" position.

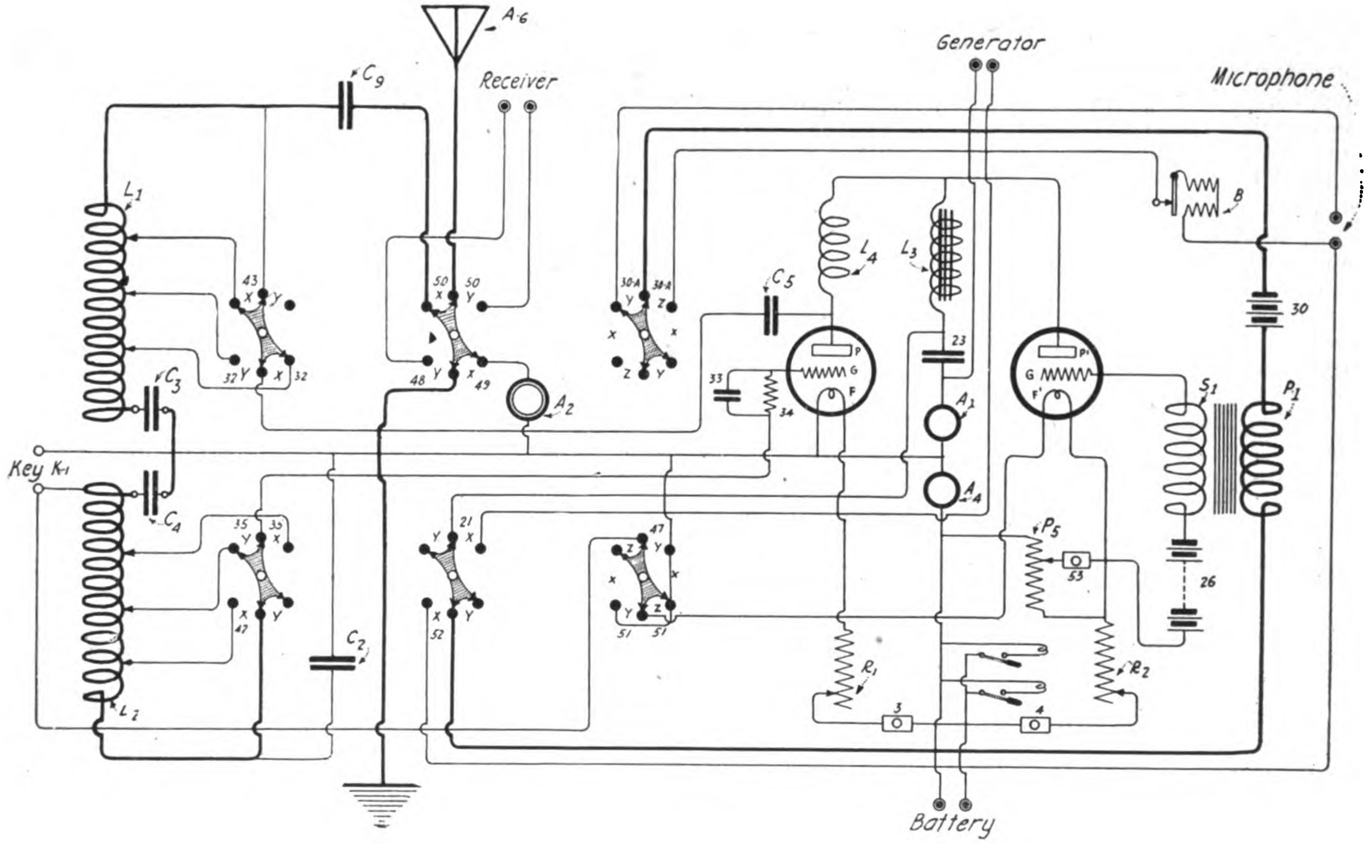


Figure 6—Wiring diagram showing the function of the change-over switches

There are three positions for the signal switch. The first, X, is for *continuous wave telegraphy*. In this position the connections made in the second and third positions are opened. The second position Y is for telephony; the inside portion of the switch (the upper part in figure 6) connects the microphone to the microphone battery, and at 51 the outside portion (in the lower part of figure 6) completes the filament circuit for the modulating valve and short circuits the key at 47. In the third position, the switch connects at 30 A the buzzer to the microphone battery and at 51 keeps the filament of the modulating valve lighted, removing the short circuit from the key.

The position of the switches in figure 6 does not correspond with their location on the set. All three switches are built to stand a maximum of 10,000 volts high frequency potential, although the potentials developed in the apparatus are considerably lower.

Meters and Their Functions

Space and weight considerations demand the fewest possible measuring instruments. A direct current ammeter A-4 is connected in series with two filaments and reads the total current taken by both of them. The instrument's scale registers from zero to 10 amperes; to read the current in either filament it is merely necessary to cut out the other one. This may be done by means of two small switches marked on the set "oscillator filament" and "modulator filament."

The principal indicator for checking up the proper operating conditions of the set is the plate current drawn by each of the valves from the dynamotor, the voltage of which, as already mentioned, is 1500 volts. This reading is obtained from the plate current ammeter A-1 of figure 2, connected in the ground leg of the supply circuit. This instrument reads from zero to 300 milliamperes and measures the total plate current taken by the oscillator and modulator. The maximum voltage developed by the dynamotor is 1600 volts and the vacuum tube generally will cease to operate when it falls below 1100 volts. The generating tube will oscillate over a wide range of plate voltages if the filament current is kept below a certain critical value. The filaments of the pliotrons are designed to operate on 18 volts.

Wiring

The entire set is wired with No. 12 B & S bare soft copper wire with empire cloth tubing slipped over it as insulation. No terminal lugs are used; the ends of the wires are bent in the shape of an eye which fits the stud terminal and is passed around it in a direction that tends to make the wire grip the stud when the nut is tightened.

The wiring has been so located that small or disturbing capacities between the wires are avoided.

Structural Considerations

Owing to the vibration of the airplane every possible precaution has been taken to prevent the fastenings working loose. Special steel lock washers are used throughout the set. The general scheme of construction is such that the main supports and fastenings will bend before they break, wood or any material which splits or fractures, having been eliminated. The steel wire cross braces shown in the photograph make the structure an extremely light and a surprisingly rigid unit.

Power Supply

The primary source of energy is two 12 volt, 50 ampere hour batteries of the Willard lead type similar to those used in automobile starters. The filaments of the two pliotrons are operated through a rheostat directly from the 24-volt storage battery. Since the tubes require a plate E.M.F. of 1,500 volts DC, a small dynamotor, driven by the 24-volt storage battery, is supplied. The armature has two windings in the same slots, one connected to the 24-volt commutator at one end, and the other to the 1,500-volt commutator at the opposite end. It is a two-pole machine excited from the 24-volt source. The armature, which runs on ball bearings at 5,000 r.p.m. and draws about 30 amperes on its full load at 450 watts, weighs approximately 30 pounds.

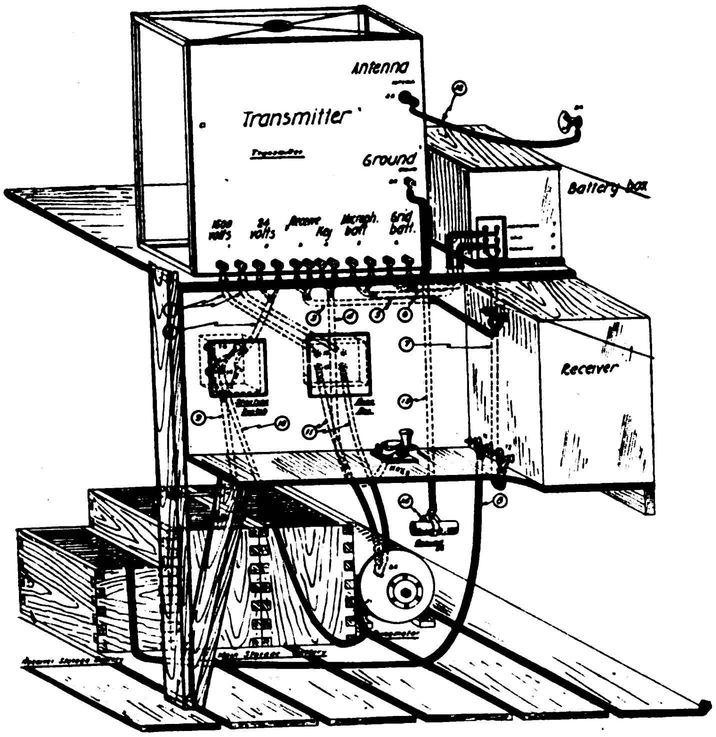


Figure 7—Sketch showing the installation of the complete set

In addition to the 24-volt storage battery, three other batteries are required; two for the transmitter and one for the receiver. These three sets are known as the *microphone battery, grid battery* and *receiver battery*. The voltage of the first is 5; of the second 60, and of the third 40. The 60- and 40-volt sets consist of 20-volt units connected in series. They are arranged in a wooden box screwed to the operating shelf. A dilecto terminal block is supplied.

The Support of the Pliotrons

To insure against breakage, the best position for the pliotrons is vertical with the large neck at the bottom. This brings the *plate terminal cap* at the top and the *filament and grid terminal cap* at the bottom. In each of the two dilecto rings shown at the top of the photograph, three spiral springs placed 120 degrees apart support a spring cap which fits over the plate terminal cap of the pliotrons. The springs are held by small machine screws which pass through the insulating ring. One of these serve as a terminal, being connected by a pig-tail to the spring tap. In each of the two bottom dilecto rings, three spiral springs, placed 120 degrees apart support a special jack block made to take the filament and grid terminals. This block is made in two halves, upper and lower, held together by screws; clamping these spring jacks between them, three posts, which project from the bottom of the jack block, take the ends of the three supporting springs, and are electrically connected by a copper pig-tail to the screw-eyes that hold the other end of the spring to the dilecto ring. The two filament terminals of the tube and the grid terminal are brought out to the three screws in the dilecto ring. Thus, each pliotron is supported to the rigid frame of the set by 6 springs which are set so that when the tube is in place the top springs pull down and the bottom springs pull up.

The mechanical period of vibration of the vacuum tubes in this spring mounting is considerably below that of any vibration that will occur in the seaplane itself. Sudden shocks in any but a horizontal direction are not transmitted through these springs with sufficient violence to injure the tubes.

The positions of all controlling appliances on the main panel board are clearly indicated in the photograph, figure 3. The small sub-panel is mounted immediately to the rear of the frame.

Reel Antenna and Accessories

The antenna reel group for this set consists of the reel mechanism, a removable drum with antenna wire and spare drums with complete antennae on them. The wire from the reel runs through a take-off pulley and passes through the lead-in insulator in the side of the hull of the boat. It then passes through either a strut pulley or wing pulley, depending upon the type of the boat.

Reel Mechanism

A cast aluminum plate, clamped to one of the main struts in the hull of the boat, carries a shaft on which the drum turns. On this same shaft, next to the attachment plate, there is a brake drum of cast aluminum, and around this drum a cast iron brake band. The band is sprung over the drum and prevents it from turning except when a cam which is attached to the brake lever springs it open. A pin on the brake drum engages holes in the main drum, when the latter is put on the shaft. The crank by which the main drum is turned has a square hub on which the drum sets. It is slipped onto the shaft, and latches in place. The latch is released by a latch handle just behind the arm of the crank. To remove the drum, to put a new one in place, the operator grasps the arm of the crank, and in so doing also grasps the latch handle and releases the latch. He then pulls the crank and drum off together. One drum may then be slipped off the hub of the crank and a new one put on, and the two slipped back onto the shaft.

Reel Drum and Antenna

The drum is a pressed steel spool, black japanned, and will hold about 600 feet of the standard antenna wire. It has a square hole at its center which fits the hub of the crank. The antenna wire has a ball at the reel end, and this ball is dropped through a hole in the drum face. The other end of the wire is attached to a swivel, and this in turn is attached to the "fish" or weight.

Lead-in Insulator

The lead-in insulator is a moulded "electrose" fitting, with a metal tube running through it, and a wide flare at either end, so that the wire cannot catch on the ends of the tube even if it enters at right angles. The insulator is held by lock-nuts in a hole in the side of the hull. The antenna connection from the set is brought to this insulator. When the antenna is out, the ball on the reel end of the wire rests against the inside flare of the insulator. The wire is thus entirely disconnected from the reel, and the reel is dead. When it becomes necessary to reel up, the ball is grasped, and of course brings the wire with it. The ball is passed through the take-off pulley and dropped through the hole in the drum face, and the crank is turned. The brake mechanism is arranged so that the cam may be left holding the brake off during the reeling-up process.

Figure 7 shows the position of the receiving storage battery, the main storage battery transmitter, transmitting key, receiver, and battery box.

The maximum antenna current is 2.5 amperes, with the antenna supplied with the set. This has been found to satisfy all ordinary distance requirements.

Comprehensive instructions are supplied with each set, enabling the operator to obtain the best adjustment for the three signaling positions with the greatest ease.

Uni-Directional Transmitting System

UTILIZING loop antennae, C. S. Franklin of the English Marconi Company has devised the one-way transmitting system shown diagrammatically in the accompanying figures 1 and 2.

It is common knowledge that a frame such as a rectangular circuit of wire placed in a vertical plane and in which high frequency alternating currents are induced, radiates electric waves best in the two directions in the plane of the rectangle, and not at all in the two directions at right angles to this plane. The polar curve of radiation is in fact in the form of the figure 8, consisting of two equal figures which are nearly circles. The waves at any two points equidistant from and one on each side of the rectangle and in its plane are at any instant of time equal and of opposite phase.

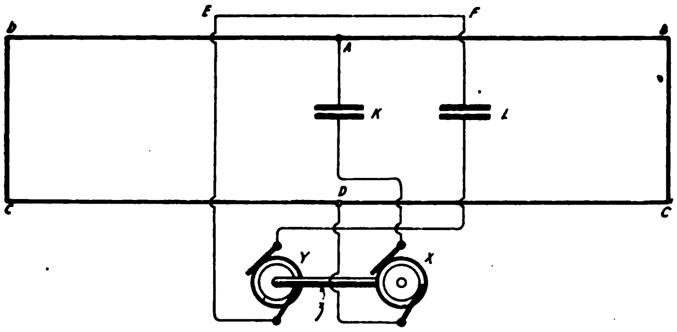


Figure 1—Circuit of the uni-directional transmitting system using two equal frames in parallel

As an illustrative example of the working of this system, two equal rectangular or frame circuits may be assumed to be erected in the same vertical plane, either so that they have one vertical edge common to both (in which case they may be considered as being in parallel), or so that they have one vertical edge of one rectangle adjacent to one vertical edge of the other, the two circuits being connected in series so that one is reversed as regards the other. Then if high frequency alternating currents are induced in the two circuits so that the currents traverse them in opposite directions, the combination will as before radiate best in the two directions in the plane of the rectangles, and not at all in the two directions at right angles. The polar curve will again be a figure of 8 made up of two similar figures which are nearly circles. In this case, however, the waves at any two points equidistant from, and one on each side of the rectangles and in their plane, are at any instant of time equal and in phase with each other.

To obtain uni-directional transmission, Mr. Franklin provides a double frame circuit in the same, or substantially the same plane with a simple frame circuit placed symmetrically with respect to the double circuit. The two circuits will have no mutual inductance or coupling effect on one another if they are properly proportioned; that is to say, alternating currents existing in one will not affect alternating currents existing in the other. Under these conditions each circuit tends to produce its own radiation independently of the other circuit.

Before proceeding further with the operating theory, a description of the diagrams will be given.

Figure 1 shows the arrangement of two equal frames in parallel, and figure 2 the arrangement of two frames in series. In figure 1, A,B,C,D, a,b,c,d are two equal rectangular aerials having the vertical side A,D common. In A,D is inserted a tuning condenser K and an oscillation generator X.

E,F,G,H is a simple rectangular aerial having a tuning condenser L and an oscillation generator Y; this aerial is erected in substantially the same plane as the double rectangular aerial and symmetrically with respect to it, so that there is no coupling between the two systems. The two oscillation generators Y and X produce oscillations of the same frequency. It is obvious that the phase of the currents in the two alternators may be varied as desired by changing their relative positions on the common driving shaft z. However, any suitable or known means may be used for producing a desired phase difference. In figure 2, A,B,C,D, a,b,c,d are two equal frames connected in series as shown.

In one direction in the plane of the system of either arrangement (provided that the relative phase of the currents in the two circuits is correct) the magnetic fields from the independent circuits are in phase and produce a wave with an energy proportional to the square of their sum; while in the other direction the magnetic fields are of opposite phase and produce a wave having an energy proportional to the square of their difference.

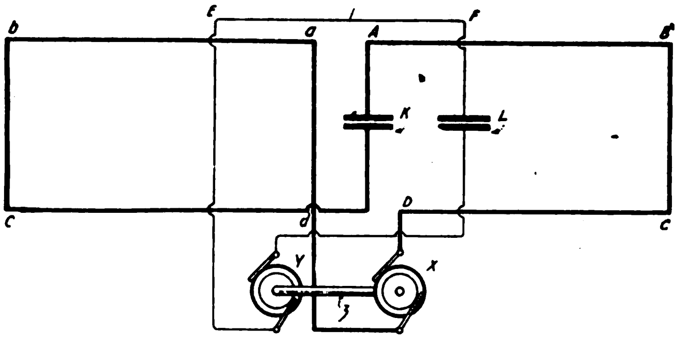


Figure 2—Circuit using two frames in series

Therefore, if the currents in the two independent circuits are so adjusted that they produce waves of equal strength, the magnetic fields in one direction in their plane will produce a wave with four times the energy of the waves from either circuit separately; in the opposite direction the magnetic fields neutralize each other and no waves are produced. In order that the fields may correctly cancel on the one side, it is necessary that the two sets of oscillations have a phase difference of 90°.

In the two directions at right angles to the plane of the circuits no waves are produced. The result is that practically all the energy is radiated only on one side of the plane, through the system at right angles to its plane. On that side the polar curves of the two frames add; on the other side of the line the two curves practically neutralize each other.

In practice it is necessary to introduce condensers into the circuits which need not necessarily be rectangles, so as to tune them to the frequency employed. To obtain the best directional effects the circuits should be entirely insulated from the earth, but good directional effects may be obtained if the earth be used as part of one or both circuits.

Fuller's Arc Generator

IN the accompanying diagrams, figures 1, 2 and 3, Leonard Fuller discloses the construction of an arc gap applicable to radio telegraphy. Figure 1 is a horizontal section of the generator; figure 2 is a horizontal longitudinal section of the anode; and figure 3 a vertical longitudinal section of the anode. The carbon cathode 2 and the anode 3 are enclosed in a casing 4 so that the arc between the electrodes may be subjected to a hydrogen atmosphere. When the generator is connected in a wireless transmission system the cathode is connected to earth and the anode to the antenna. Powerful magnets are mounted at right angles to the arc to increase the efficiency of conversion. A very small potential difference exists between the magnet poles and cathode, but between the anode and the poles the potential difference is relatively high and, accordingly, in the ordinary construction there must be greater spacing at this point than between the cathode and the poles.

It is desirable for maximum flux density that the air gap between the poles be small. This gap cannot be small on account of the potential difference mentioned, unless the construction is in accordance with the drawings. Arranged on opposite sides of the casing, and having their poles 5 extending into the chamber thereby formed, are the electromagnets 6. The anode 3 is provided with a tip 7 of much less width than the cathode, so as to give the requisite spacing between the anode and poles. The anode is a hollow metallic body and the tip is made of copper, which is hollow and is of rectangular cross section. The tip is secured to the anode body by a screw cap 8, the joint between the tip and the body being sealed by a metallic gasket 9.

During the operation of the generator, the temperature of the anode becomes excessive and would rapidly fuse if it were not for a stream of water which is introduced into the anode through the conduit 12.

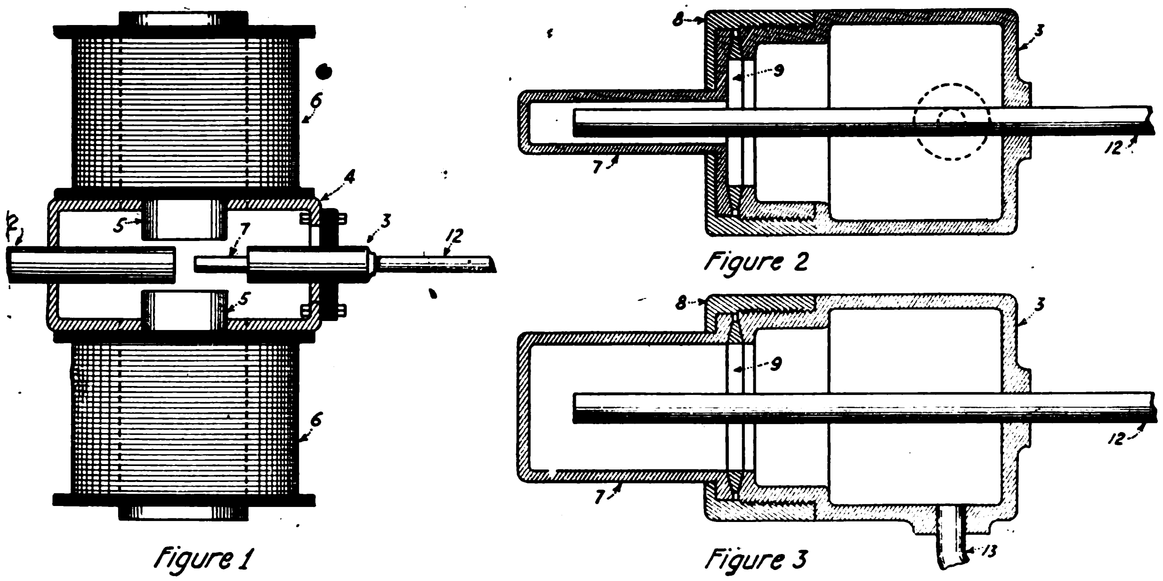


Figure 1

Figure 2

Figure 3

Drawings showing detailed construction of Fuller's arc generator for use in radio telegraphy

Undamped Wave Detectors

W. SCHLOEMILCH of Berlin has recently been acknowledged the inventor of several forms of the sliding wire ticker, a device which has been used experimentally and commercially for a number of years.

Three different embodiments of the device are shown in figures 1, 2 and 3. Figures 4 and 5 indicate the connections of these detectors in receiving circuits and figures 6, 7 and 8 are a front elevation, side elevation and top plan view, respectively, of a constructional form of the ticker. In figure 1, the silver or gold wire electrodes A and B are in contact, the resistance being changed by the vibrations of the buzzer 15 operated by the battery 16. In the particular construction shown in figure 2, the sliding contact is formed by two springs A-1 and A-2 pressing on an endless wire B-1, which is rotated by the wheels or rollers C and E. In figure 3, the stationary contact piece is an adjustable spring A-3, and the movable contact a revolving disc B-2 which can be driven by a motor.

In figure 4, the wave detector A is connected in series with an oscillatory circuit such as the secondary of the receiving transformer, choke coils G and H being provided to prevent the passage of high frequency oscillations through the telephone. In figure 5, the sliding contact detector A, B is located in an aperiodic circuit K which is coupled to the oscillation circuit I.

In the drawings, figures 6 to 8, the detector comprises the disc 1 provided with vanes which are rotated rapidly by clock-work contained in the casing 12. The point of the fine upwardly bent platinum wire 3, bears against the under side of the disc 1. To obtain maximum signals, the inventor provides a vertical adjustment and the regular adjustment of the sliding point. For the vertical adjustment, the platinum wire is attached to the bushing 4, which can be rotated about a horizontal axis by a handle 5. This bushing is attached to two iron levers 6 which can be rocked about a horizontal axis 8 by means of an adjusting screw 7. The first device permits rough adjustments, and the second, fine adjustments. The entire pressure adjustment is rotatable about a vertical axle 9 so that platinum wire can be adjusted radially relatively to the axis of the disc 1. The relative speed between the wire and the disc may therefore be varied at will.

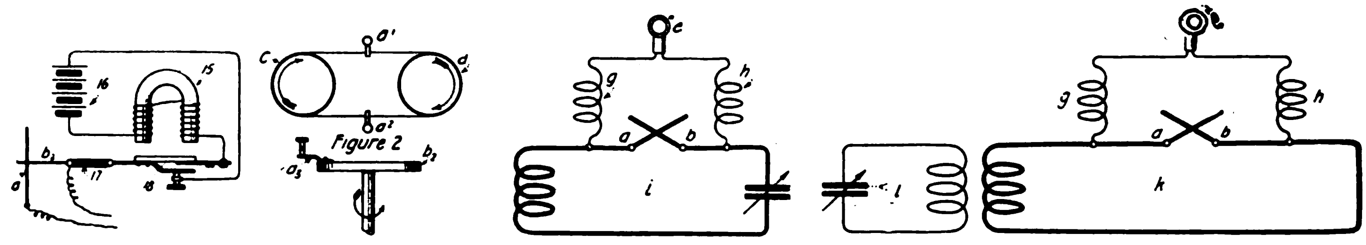


Figure 1 Figure 3 Figure 4 Figure 5

Diagrams showing three forms of the sliding wire ticker and two types of connections

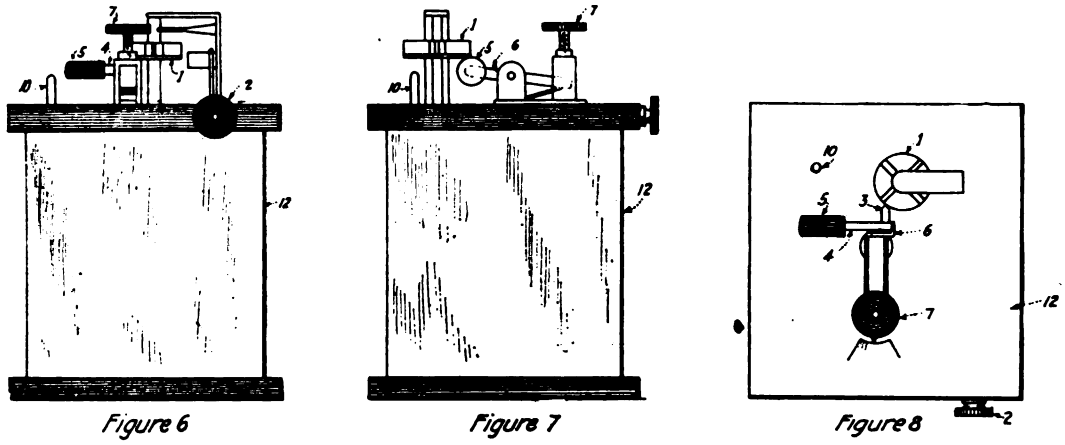


Figure 6 Figure 7 Figure 8

Diagrams showing in numerical order, the front view, side view, and top plan view, respectively, of a constructional form of the ticker

White's Automatic Radio Telephone System

IT is customary in some radio telephone systems to provide an electromagnetically operated change-over switch to alternately connect the transmitter and receiver to the wireless aerial. This is not always a convenient procedure unless the apparatus is operated by one skilled in its use; for a condition is apt to arise where both parties place their apparatus in a transmitting position, and endeavor to talk to each other simultaneously.

To overcome this objection, William C. White has devised the method of automatically changing from a trans-

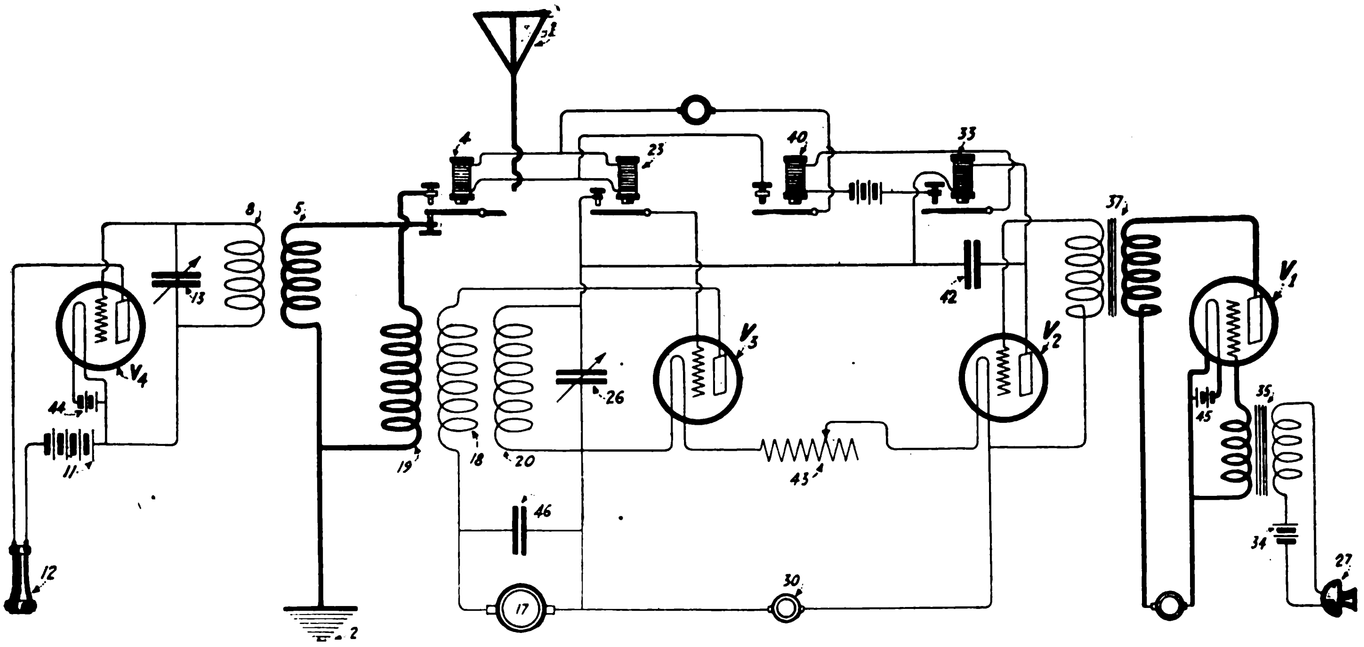


Figure 1—Diagram of White's automatic radio telephone system

mitting to a receiving position shown in the accompanying diagram figure 1, which embraces the complete circuits of a wireless telephone system. In the diagram, the three-electrode tube V-1 amplifies the speech frequency currents generated by the microphone 27. The output circuit of V-1 is coupled to the input circuit of V-2, which is the modulator bulb. The modulator in turn varies the output of the oscillating bulb V-3, which is coupled to generate radio frequency currents at any desired frequency. V-4 is the detecting tube with the usual controlling appliances, including the receiving transformer, 5, 8 and the telephone 12.

A condenser 42 in the plate circuit of the bulb V-2 is shunted by a magnet 33 which opens and closes the relay contacts shown directly underneath. The closing of these contacts energizes the magnet 40, which in turn closes the circuit to the magnets 23 and 24. When relay 4 operates, it breaks contact at 3 and makes a second contact at 25, thus connecting the coil 19 between the antenna and ground and disconnecting the receiving apparatus from the antenna. The relay 23 operates the contact 22 which, when open, prevents the bulb V-3 from generating radio frequency oscillations. When the microphone 27 is spoken into, the transmitter is automatically connected to the antenna as will now be explained.

When the transmitting apparatus is not in operation, the current which flows through the relay winding is not sufficient to operate it, but when the microphone is spoken into the currents thus produced flow through the transformer 37 and reproduce, in the plate circuit of the controlling bulb V-2, variations at speech frequencies, the average value of which will be much greater than the normal current in the plate circuit and will be sufficient to operate relay 33 which in turn operates the other relays previously mentioned. Relays 33 and 40 should be quick acting, and relays 4 and 23 should be quick to close, but should have an appreciable time lag in opening to prevent the transmitting apparatus from being disconnected during a momentary cessation of the sound waves acting upon transmitter 27. The time lag is preferably greater for relay 4 than for relay 23, in order that relay 23 may open and thus stop production of the oscillations before the antenna circuit is broken at 25.

Bellini's Electrostatically Coupled Goniometer

THE Marconi-Bellini-Tosi radio goniometer has been employed in wireless telegraphy for many years. As many of our readers know, the two loop antennae in this device are magnetically coupled through two primaries to a rotating coil which may be revolved on its axis in the resulting magnetic field.

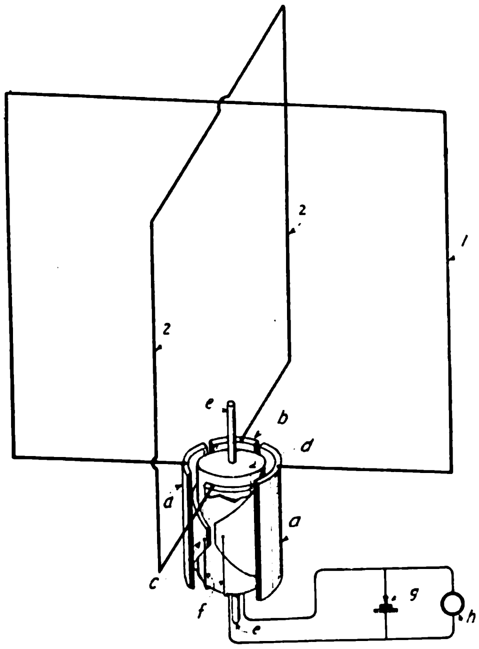


Figure 1—Diagram showing the connections of a goniometer, receiving detector and head telephones

Ettore Bellini, who is a pioneer in directive radio telegraphy, has recently described the capacitively coupled goniometer shown in figure 1. Here two loop antennae 1 and 2 are connected to pairs of stationary plates aa and bb arranged around an axis. On the shaft e is mounted a drum d, upon which are placed the conducting elements c. It is preferable that the conductors have the form shown in figure 2, which when extended in a plane, has the outline formed by two sinusoidal curves, or by the portion of the enclosed surface situated above the axis of the abscissae, s, t. The two plates c (of figure 1 or figure 3) must not touch each other, but must be very close together. The action of the stationary plates is apparently to set up a resultant electrostatic field, the direction of which in the goniometer varies as the direction of the advancing wave. By rotating the inner drum, it may be placed in a position to receive the maximum induction from the stationary plates.

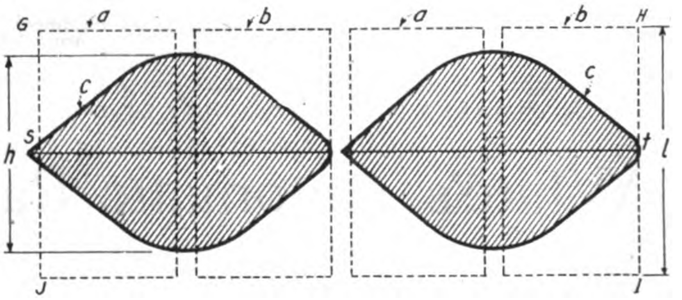


Figure 2—Improved type of conductors

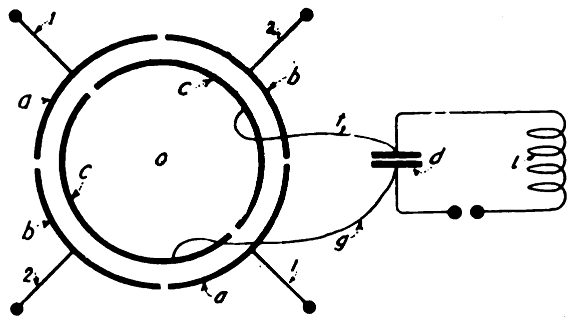


Figure 3—Circuits for directive transmission

The diagram figure 1 shows the connections of a receiving detector g with head telephones h in shunt. Figure 3 shows the circuits for directive transmission, the rotating plates cc being connected to a circuit comprising the condenser d, inductance i and the spark gap. In this diagram 1, 1 and 2, 2 are the terminals of the two loop antennae. The rotating element therefore serves to impress high frequency currents from a local generator upon the antenna circuit, and to receive radio frequency currents sent out by the distant transmitter.

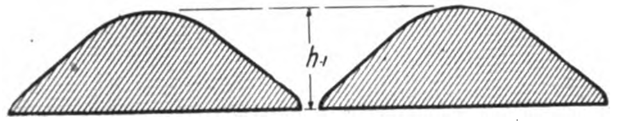


Figure 4—Another form of the improved conductor

Figure 4 shows another type of movable plates which can be used in place of those shown in figure 2. Bellini states that, as with the well-known magnetically coupled goniometer, this system can be employed for directive transmission or reception.

Aviators' Intercommunicating Telephone System

G. M. JENKINS, realizing the difficulty of a pilot and observer in an airplane talking to each other on account of the whir of the propeller, the rush of air and the exhaust of the motor, has devised a telephone system including a transmitter and receiver which are strapped to the aviator's head. Moreover, he has provided a switching arrangement so that when the talker puts his head forward to speak a switch is closed, connecting the transmitter into the circuit. This automatic feature is of considerable value, for it leaves the pilot's hands free for manipulating his control levers and prevents a drain on the transmitter battery during the period when no conversations are taking place.

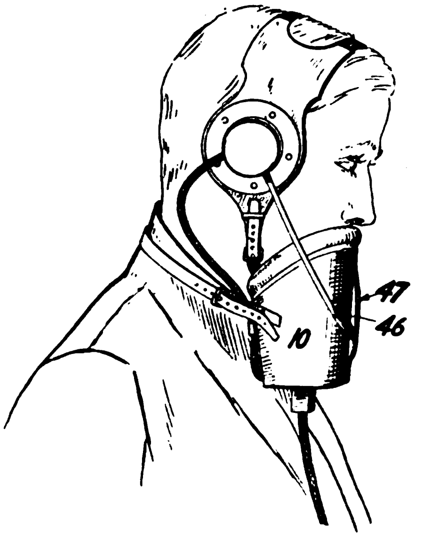


Figure 1

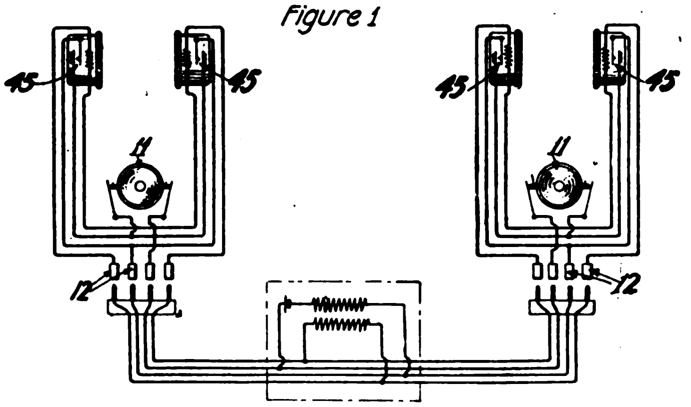


Figure 2

Transmitter and receiver adjusted to operator and diagram of circuit employed

Figure 1 shows the transmitter and receiver in position for operation; figure 2 is a diagram of the circuits employed; figure 3 is a front elevation of the transmitter box, a portion of which is cut away to show the mounting in the transmitter. Figure 4 is a side elevation and figure 5 a plan view of the transmitter box in figure 3. Figures 6 and 7 show a head band for holding the receivers, one receiver being shown in position and a portion cut away to show the operation of the transmitter switch.

Each pilot or observer is provided with a transmitter box 10 of leather, adapted for the mounting of the transmitter 11, and a set of four line terminals or jacks 12. The upper portion of the box 10 is provided with a cushion consisting of a soft rubber tube 13 and a soft leather casing 14.

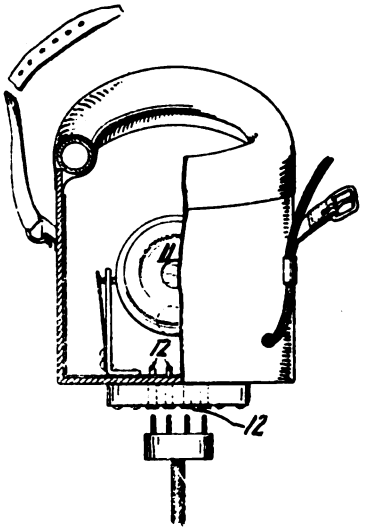


Figure 3

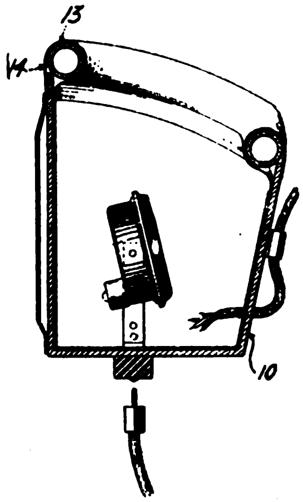


Figure 4

A front and side elevation of the transmitter

On each receiver is a transmitter switch 45 arranged for connecting the transmitter in a circuit automatically when the user lowers his head to transmit. The switch is operated by a wire 46 which extends in a loop from the two head receivers and passes under a strap 47 on the front of the transmitter box 10.

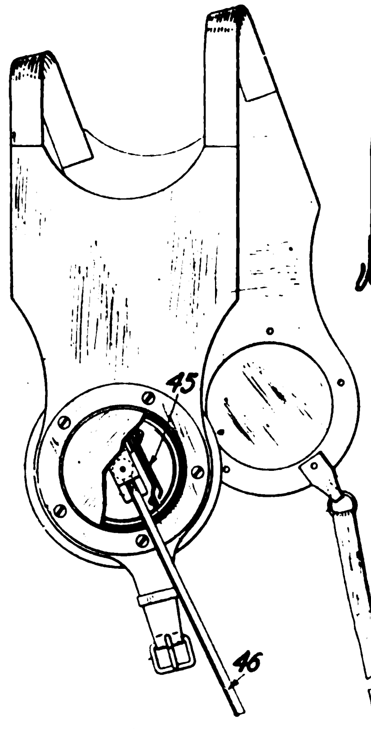


Figure 6

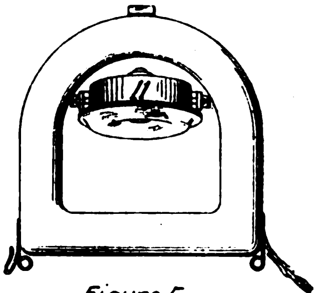


Figure 5

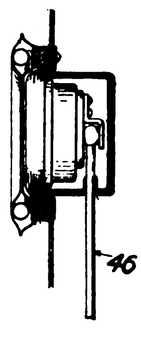
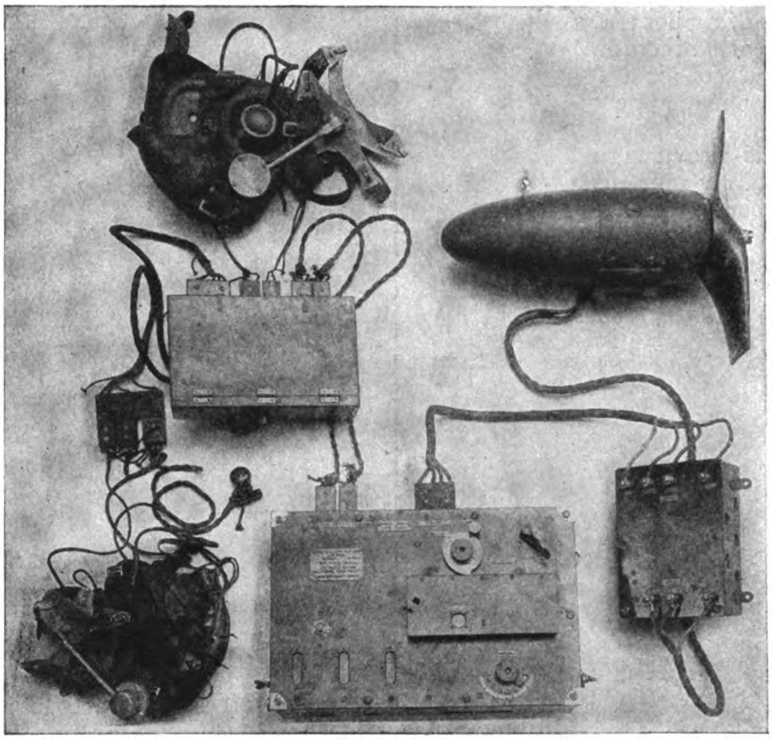


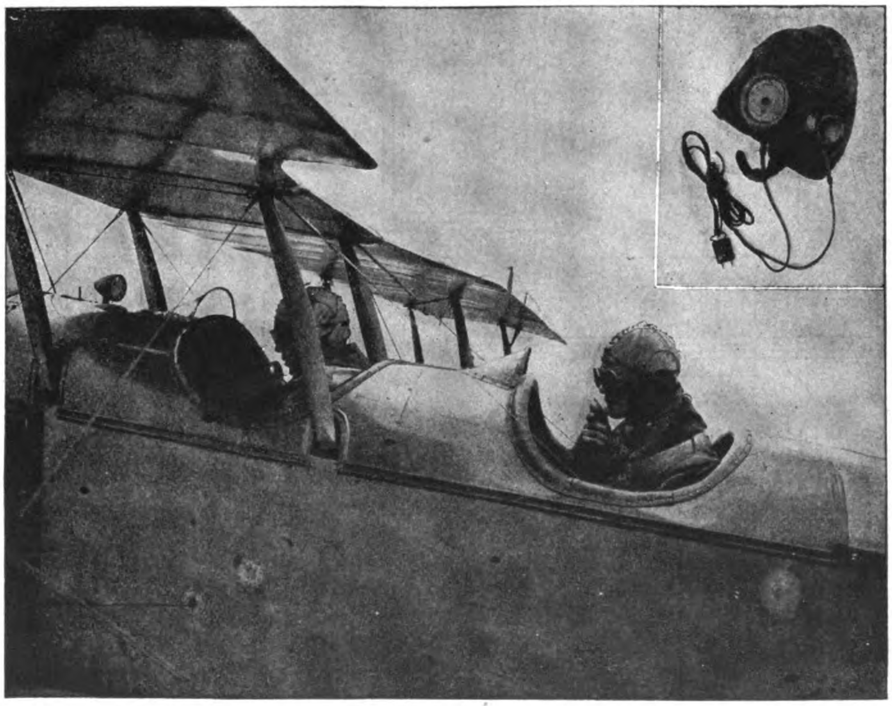
Figure 7

A plan view of the transmitter box and head band for holding thereceiver

Army Airplane Apparatus

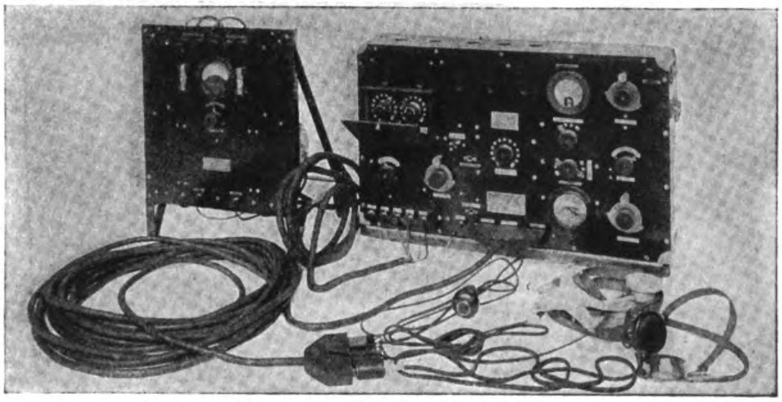


Complete airplane radio telephone set developed for the U. S. Army during the war. This set, known as SCR-68 occupies only one cubic foot of space and weighs 45 pounds. The transmitting circuit includes the antenna capacity as part of the tuned circuit in which a vacuum tube maintains high frequency oscillations, the magnitude of these being controlled by a second tube, which in turn is controlled by the voice currents from the transmitter. The receiving set employs a tuned circuit and a vacuum tube detector, the speech output of which is amplified by two vacuum tubes



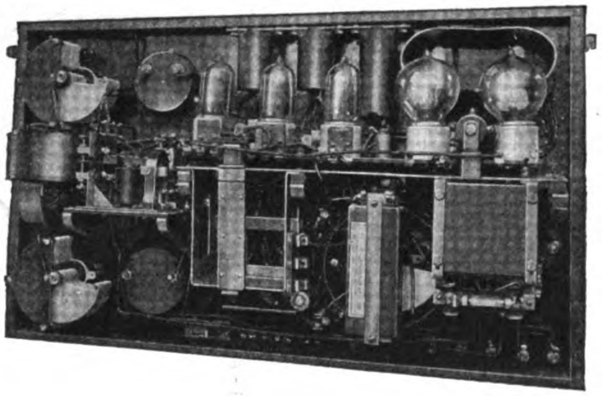
The inset shows the specially designed helmet by which the noise and wind encountered while in flight are overcome and conversation is made possible. In the practical use of the set the observer uses the same telephone equipment for radio and for communication with the pilot

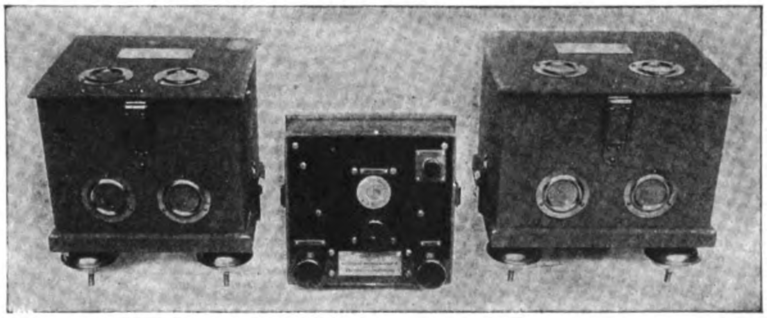
Ground and Short Wave Sets



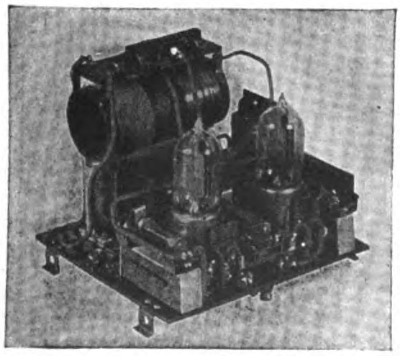
For use on the ground, in talking to observers in airplanes, the U. S. Army used the set illustrated on the left. It is known as type SCR-67 and is similar in principle to the aircraft equipment, but as space and weight are not so restricted, this outfit is designed with a doubly tuned receiving circuit so greater selectivity may be obtained

On the right is an interior view of the ground radio 'phone set illustrated above. A single tuned circuit permits a "stand-by" adjustment for detecting speech, which is transmitted by modulating any one of a wide range of high frequencies. The operator may then quickly adjust for the selective reception of the desired conversation. This equipment also functions under remote control, so that the speaker may make observations of the planes with which he is communicating by standing in the open while the set with which he is connected is protected under cover

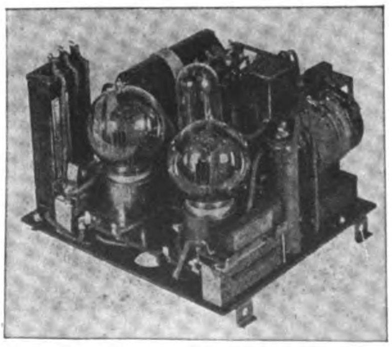




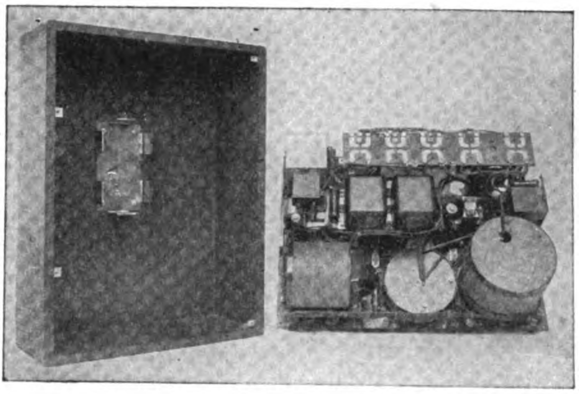
The complete SCR-91 short wave set designed to eliminate the long trailing wire antenna. Its range is from 86 to 116 meters. In the center is a control panel which is mounted before the pilot in the cockpit operating a special set of amplifiers

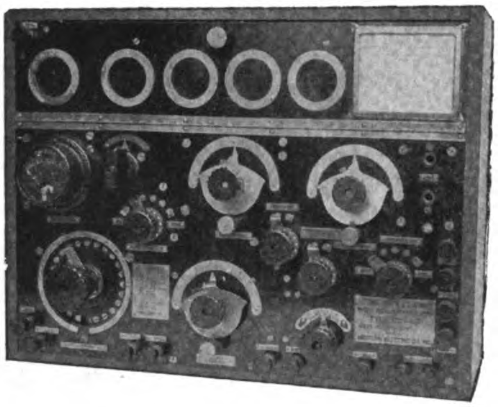


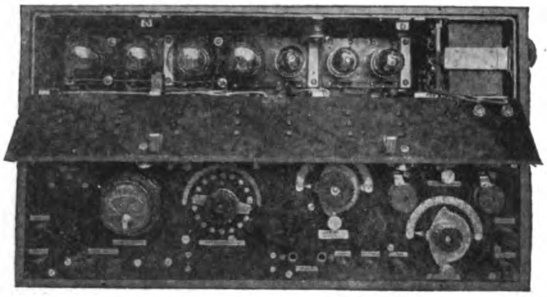
To the right is an interior view of the transmitter, and to the left an interior view of the receiver of the complete set illustrated above. In the receiving equipment space is saved by utilizing a system of amplification whereby the output of the detector tube is successively applied to it as an input until a limiting critical amplification is reached



Varied Military Equipment

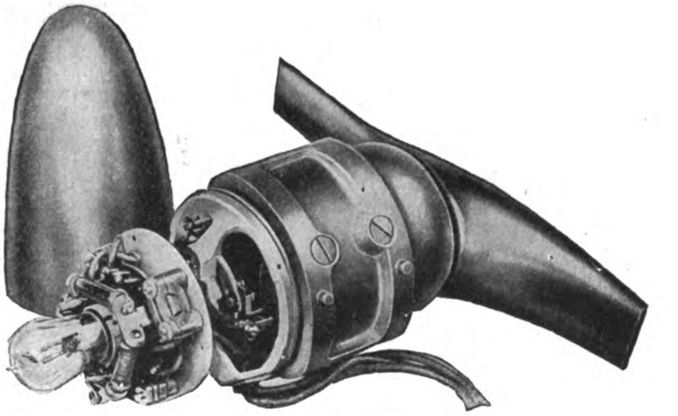




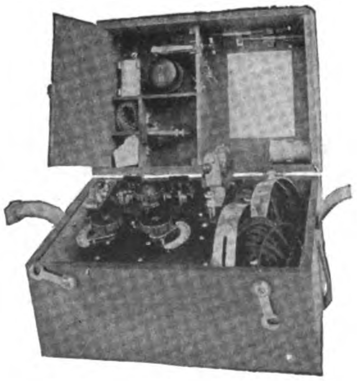


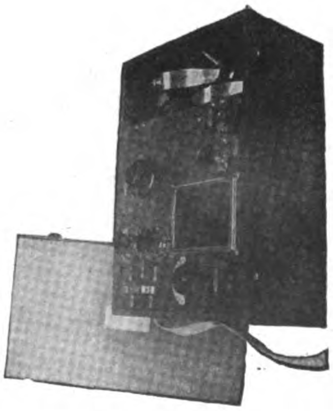
The two illustrations above are interior and exterior views of the radio telegraph set, type SCR-99, for army field use. Two vacuum tubes are used in the oscillating circuit for continuous wave transmission. This equipment is designed for beat reception of continuous wave signals and is also capable of receiving spark set signals

On the left is wireless telegraph set type SCR-78, designed especially for tanks, to enable them to advance as protected signal stations. Only the smallest antenna could be used, and the problem of obtaining the necessary power output was met by using an oscillating circuit involving four vacuum tube amplifiers



Wind-driven generator for airplane sets, showing regulator which supplies both a 24-volt current for the filaments and a 350-volt current for the plate-filament circuit. The speed of this generator, varying through wide limits, required special means for voltage regulation, found by utilizing characteristic properties of a thermionic vacuum tube, the bulb itself being mounted in the stream line extension of the generator

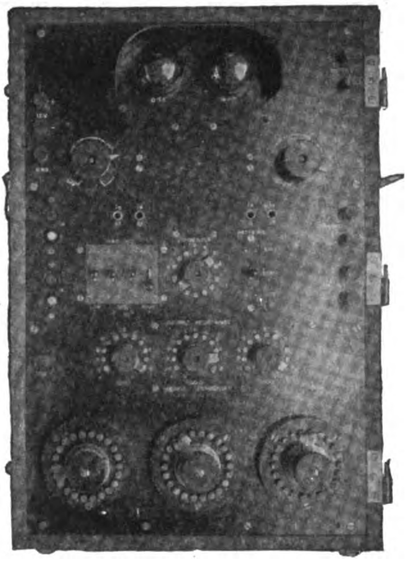




To the left is wireless telegraph receiver SCR-54, using a crystal detector and patterned on sets in use by the French Army in the earlier years of the war

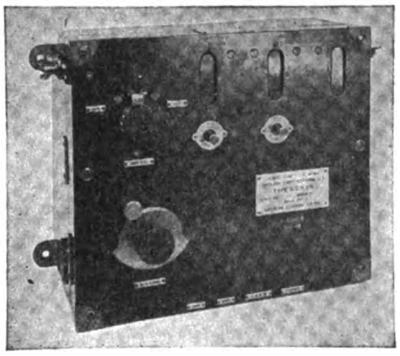
To the right, the familiar SCR-70 special wireless receiving set used in instructing aviators and other radio operators

Recently Developed Apparatus

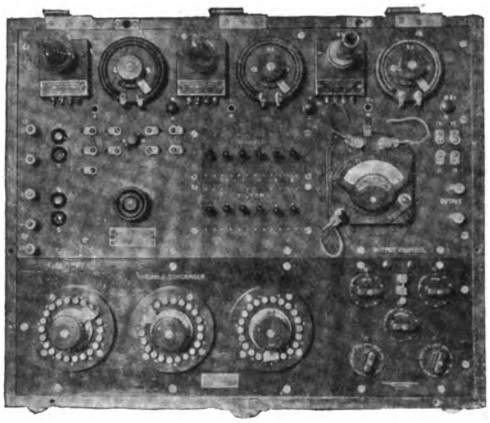


Oscillator for very low frequencies

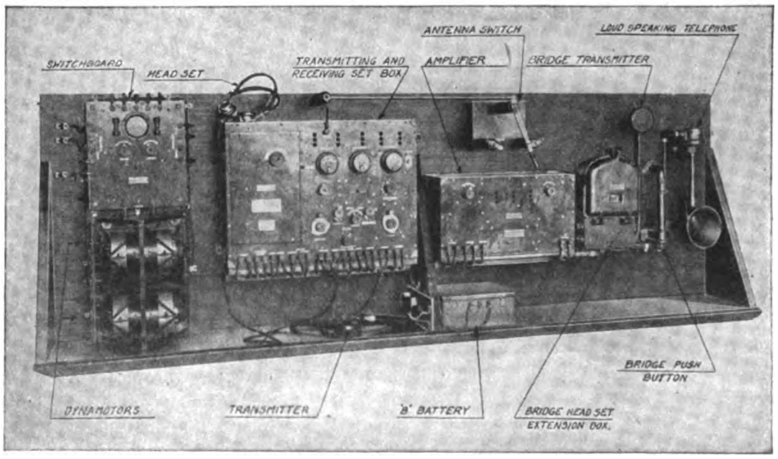
Interior view of SCR-68 wireless telephone set



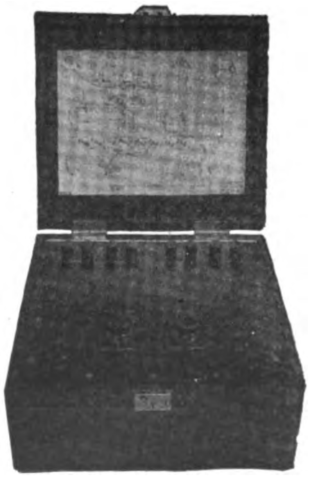
Double tuned ground receiving set SCR-59



Audio frequency oscillator



Navy wireless telephone set designed for use by submarine chasers



Portable 3-stage amplifier

EXPERIMENTERS' WORLD

Views of readers on subjects and specific problems they would like to have discussed in this department will be appreciated by the Editor

A Universal Radio Receiver for Amateur Use

By Morton W. Sterns

IT has been the writer's good fortune to meet many hundreds of radio amateurs since the war began, and it has been his observation that their main concern has been to obtain the details of the design of a receiver that will permit reception over great distances for relay work. Although a variety of opinions and designs have been set forth as to what constitutes the best all around receiver, the most of them are, in the author's opinion, either too difficult to construct or too expensive for the average amateur's pocket-book.

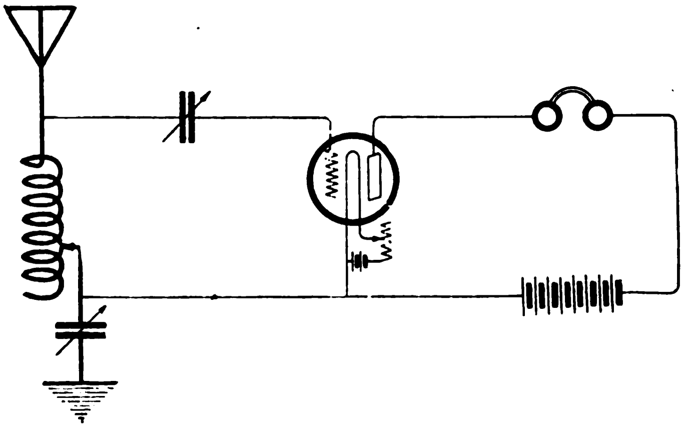


Figure 1—Fundamental circuit showing three-electrode vacuum tube connected across a tuning coil in series with the antenna circuit

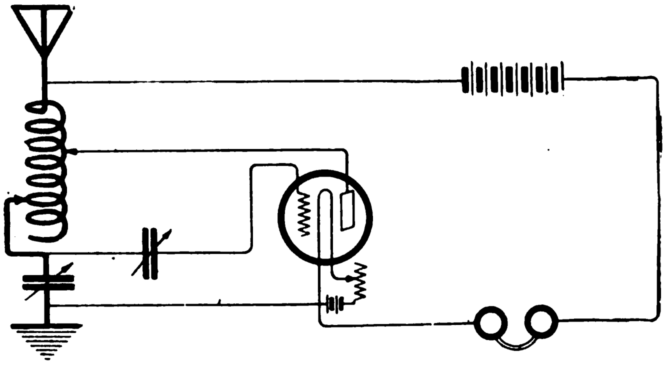


Figure 4—Circuit using one coil and one condenser and employing direct regenerative coupling between the plate and grid circuits

The writer has given the matter his serious consideration for some time and has finally evolved a set which it is believed possesses many desirable characteristics. Keeping in view the desirability of an efficient receiving set that would occupy a minimum of space, a set was eventually produced that would give a range of tuning from 130 to 1850 meters with a small antenna of .0005 mfd. capacity. As will be noted further on, this same set gives a three mile range either as a radio telegraph or radio telephone transmitter. A single bulb is used for all work and the circuit has proved especially efficient on short amateur wave lengths. The entire set occupies a space less than a two foot cube. It is not only feasible for the reception of damped and undamped waves, but it gives regenerative amplification and constitutes a very neat and efficient wireless telephone set.

FUNDAMENTAL CIRCUITS

A series of exhaustive experiments with various types of circuits have been carried out. Very good results were obtained with the circuit shown in figure 1, where a three electrode vacuum tube is connected across a tuning coil

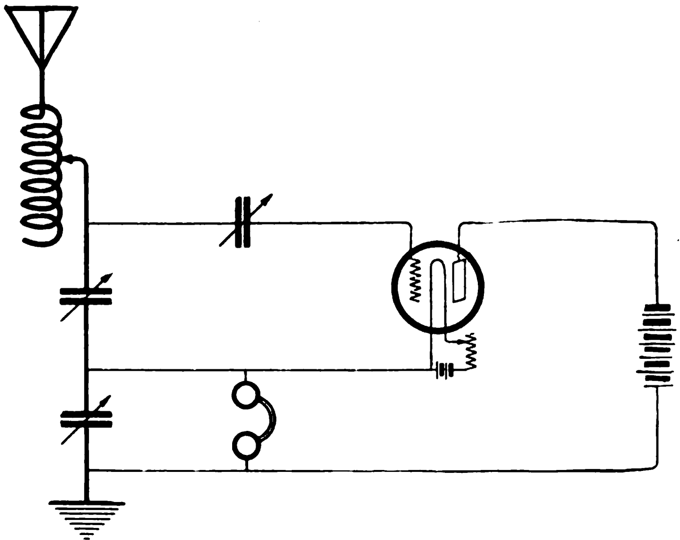


Figure 2—Another circuit using two variable condensers

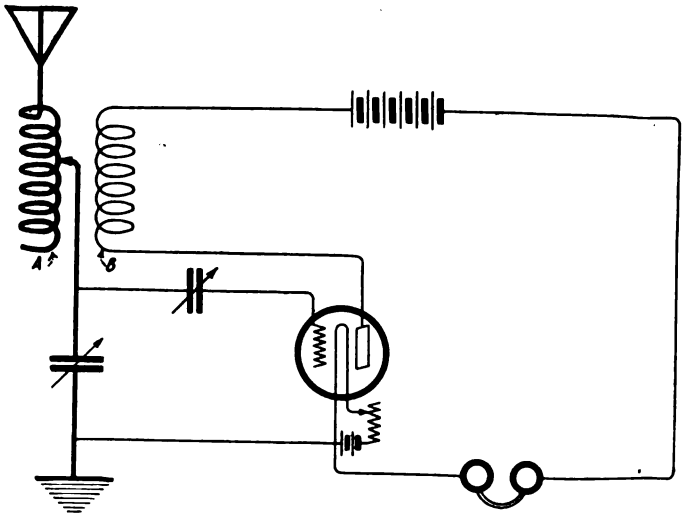


Figure 3—A circuit patented by C. V. Logwood using a regenerative coupling to transfer energy from the plate to the grid circuit

in series with the antenna circuit. The principal objection to this particular circuit was that it was not capable of receiving continuous wave signals.

The circuit of figure 2 was found to give very good results, but the local oscillations were not easily controlled and, furthermore, it necessitated the purchase of two variable condensers as shown.

Very satisfactory results were obtained with the circuit of figure 3 which, it is stated, has been patented by C. V. Logwood. In that diagram coil B is a tickler coil of a comparatively few turns of wire mounted inside of coil A, constituting a regenerative coupling by which energy can be transferred from the plate to the grid circuit. It is a feature of this circuit that the oscillations can be started or stopped simply by moving the coil B in and out of the coil A.

Having determined the good and bad features of the circuits described, I carried out further experiments with the view of obtaining greater simplicity. In fact, I was determined to have one coil and one condenser, and my researches eventually culminated in the circuit shown in figure 4, in which direct regenerative coupling between the plate and grid circuits is employed. Once having discovered a fundamental basis upon which to work, and having observed that the mutual inductance between the plate and grid circuits could be controlled by a single coil, various combinations were tried employing grid leaks, negative grid voltages, etc. Some useful results were obtained, but the experiments finally terminated in the universal circuit shown in figure 5, which it is believed is the acme of simplicity and moreover gives extremely sharp tuning.

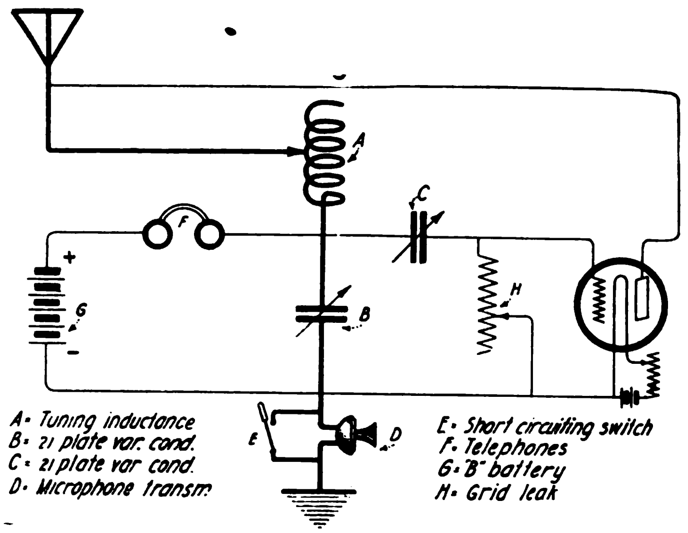


Figure 5—The perfected circuit of simple design and extremely sharp tuning

The notations in the diagram are explained in the accompanying drawing.

Coil A in the diagram has three taps. The switch is placed on one tap and the condenser B is varied over its range until the desired signal is heard. Since the tuning is exceedingly sharp, care must be taken while adjusting this condenser not to miss the signal. It is understood, of course, that the switch E is closed while receiving, but it is interesting to note that by varying the capacity of the condenser C, the bulb can be made to give regenerative amplification or to generate powerful oscillations, hence the circuit can be used for wireless telephone transmission as well.

By way of further explanation of the circuit, H is a grid leak which is of the order of 60,000 to 100,000 ohms resistance for the audiotron or the round bulb. This leak can be made a pencil mark, between two binding posts of a Ward Leonard porcelain resistance or a graphite potentiometer such as used in the B battery circuit. The latter type is particularly handy, because it is variable. It must be understood that the grid leak is essential for proper working of the system, but once adjusted it need not be touched during the life of any particular bulb. The plate circuit voltage in this system varies between 60 and 80 volts or even higher if possible.

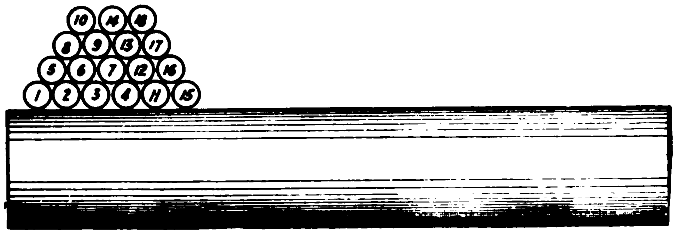


Figure 6—A four-bank winding showing the order in which the turns are placed upon the tube

Use of the Circuit for Wireless Telephony

To engage in wireless telephone conversation, open the switch E and speak into the microphone distinctly, making sure that the bulb is in a state of oscillation. An indicating device of some sort, such as a small ammeter, should be placed in the antenna circuit to determine the maximum antenna current. The plate voltage should be as high as possible without causing the bulb to ionize; that is, to give the characteristic blue glow. And if any amateur possesses a "hard" bulb that proved inoperative in an ordinary receiving circuit, he should now put it into use, because for transmitting purposes, the "harder" the bulb the better will be the results obtained.

In order to telegraph by means of continuous waves, place the key in series with the grid leak. This will cause the bulb to stop oscillating whenever the key is up.

In the construction of this apparatus it is preferable that the receiving cabinet proper contain only the tuning inductance and the 21-plate variable condenser. The vacuum tube control panel is separate, and a sufficient number of binding posts are brought out to allow any desired connection to the tube. The connections from the inductance switch are brought to the binding posts on the receiving panel. Other posts are provided for connection to the antenna and ground. Additional leads are brought out from the variable condenser to binding posts.

The tuning coil is wound with "litzendraht" or No. 18 B & S D.C.C. wire on a tube three inches outside diameter. A four bank winding is employed as shown in figure 6, the numbered circles showing the order in which the turns are placed upon the tube. A section of fifty turns is wound on the spool and a space of ⅜ of an inch is left, after which another section of 240 turns is wound on with a tap placed at each 55 turns. The writer employs, preferably, litzendraht cable composed of 42 separate strands of No. 36 B & S enameled wire with a double silk covering.

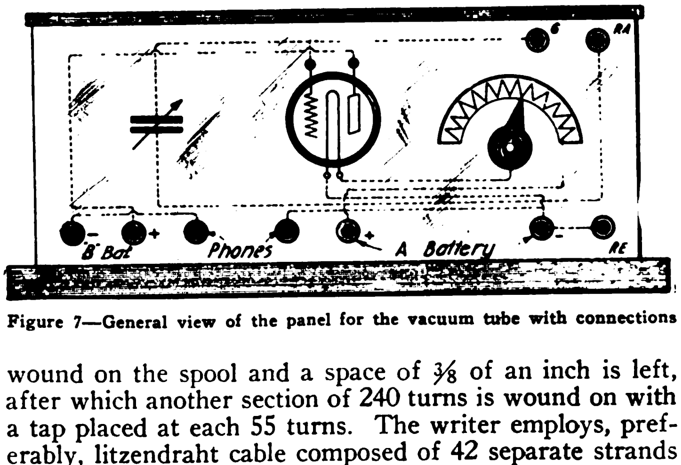


Figure 7—General view of the panel for the vacuum tube with connections

Figure 7 shows a general outline of the panel for the vacuum tube. It contains a variable condenser, the vacuum tube holder and a filament rheostat, all mounted inside the box. The panel is of 3/8 inch bakelite. The connections are brought out in such a way that any desired hook-up can be employed.

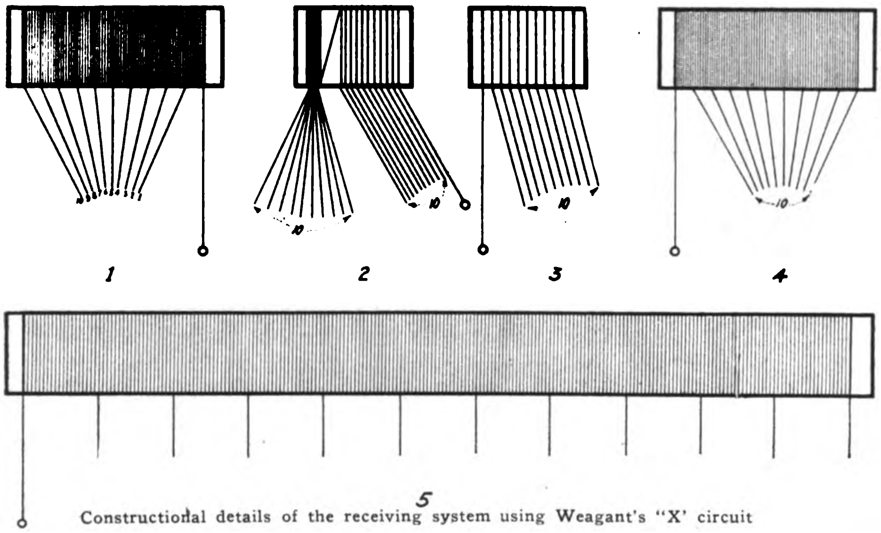
A feature of construction that the average amateur would do well to incorporate in his set is the method of fastening the panels to the box. Several right angles of 1/16 inch brass are made and screwed to the side of the box. The panel is then lowered and rests on the angles as a support, leaving the panels flush with the top of the box. Holes are then drilled through the panel and spotted in the brass angles. The holes are then reamed out to give clearance for a small machine screw; the brass in then drilled and tapped to fit the machine screw. Constructed in this way, the panel can be removed from the box as often as desired without stripping the thread in the wood, as might happen if wood screws are employed.

In closing, it is well to remark that the final circuits shown in this article can be used directly with the Western Electric "E" type tube fed from a 220 volt direct current force of supply. The bulb will give antenna current of 0.8 ampere and telephone conversations with this amount of current have been heard seven miles away. Other types of bulbs I have employed permit transmission over distances of three miles.

Constructional Details of a Wireless Receiving System Involving Weagant's "X" Circuit

By E. T. Jones

I HAVE experimented with many circuits for the reception of damped and undamped waves but the one described here gives better all-around results than any other I have used. The complete circuit acts as a detector, oscillator and amplifier for both long and short damped or undamped waves. An outstanding feature is that but one bulb is required for reception over great distances.



Constructional details of the receiving system using Weagant's "X" circuit

With a circuit of this kind I have copied signals from Nauen and Eilvese, Germany; Canarvon, Wales; Koko Head, Hawaii; Pearl Harbor, Hawaii; not to mention the arc stations located in the United States, the signals from which come in at audibilities of approximately 5,000. Signals have been read from the new high power station in Japan testing with Koko Head. These signals were plainly readable at New Orleans at 8 o'clock in the morning. One point that stands out particularly in connection with the operation of this set is, that by careful variation of the condenser capacity in the grid and plate circuits, adjustments can be obtained whereby the circuits are just on the verge of radio frequency oscillation, causing great amplification of spark signals; and by further adjustment of the condenser capacities, the circuits may be set into oscillation at any desired frequency permitting the reception of undamped waves.

Still another feature of this apparatus which I believe will appeal to the amateur experimenter is that wave lengths ranging from 600 up to 20,000 can be received without having the usual duplex receiving transformer, a multiplicity of change-over switches, etc. In fact, my entire series of experiments leads me to believe that too much praise can not be given this circuit for general experimental work. It is described in pages 102 to 105 of Bucher's "Vacuum Tubes in Wireless Communication," which explains vacuum tube detector circuits in detail.

Constructional details and dimensions of the tuner which I have found very satisfactory under the most exacting conditions follow; the antenna loading coil is wound on a tube 4" in diameter and 12" long covered with one layer of No. 24 S.C.C. magnet wire. Taps are taken off every inch, making a total of 10 taps. The winding is eleven inches in length. A general view is shown in figure 1.

A direct coupled receiving transformer is employed as shown in figure 2. It is wound on a tube 4" in diameter and 6" long covered with one layer of No. 24 S.C.C. wire. Taps are taken off every 10 turns, making a total of 20 taps. Two switches with

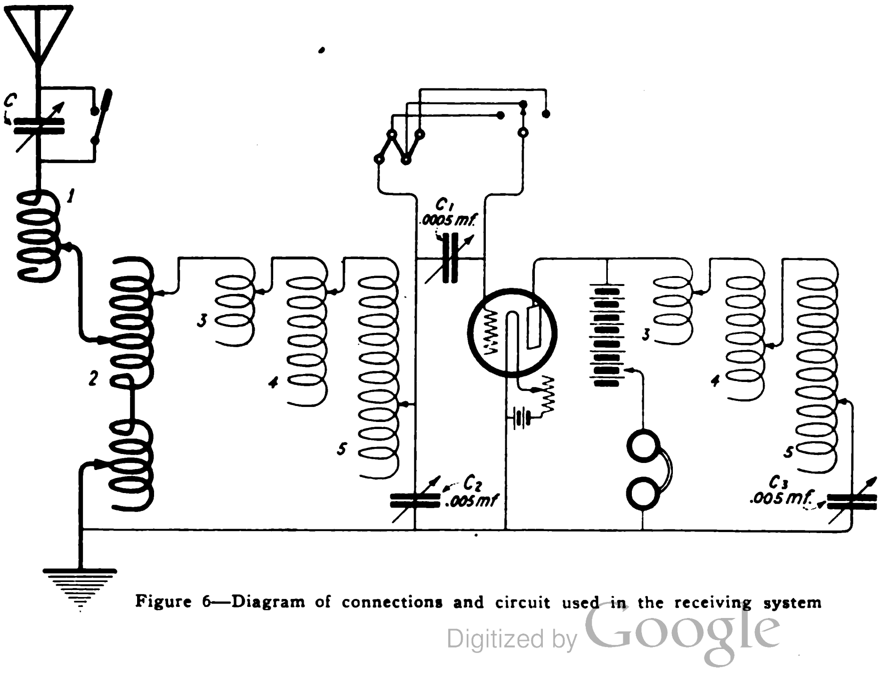


Figure 6—Diagram of connections and circuit used in the receiving system

ten contact points are provided. Each contact point is connected to successive tenth turns. A unit switch is also supplied which connects to the first ten turns, one at a time, as shown.

The short secondary coils shown in figure 3 are made on tubes 4" in diameter, 6" long wound with one layer of No. 24 S.C.C. magnet wire. Taps are taken off every half inch, making ten taps per coil, or a total of 20 taps. The two loading coils of medium length are made of tubes 4" in diameter, 12" long wound with one layer of No. 24 S.C.C. magnet wire. Taps are taken off every inch, making a total of 20 taps for the two coils.

The large loading coils for long wave lengths are made on tubes 4" in diameter, 36" long, wound with one layer of No. 24 S.C.C. magnet wire. Taps are taken off every 3". The details are shown in figure 5.

The variable condensers in the secondary circuit and plate circuits should have a capacity of at least .001 mfd. and for the very long wave lengths a capacity of .005 mfd. is desirable. The grid condenser should not exceed a capacity of .0005 mfd. or thereabouts. A grid leak of the type shown in figure 6 is necessary for stable operation. It may be made of high resistance strips of graphite or lead pencil lines drawn in a groove, or of carbon typewriter paper. A three point switch is connected as shown in figure 7.

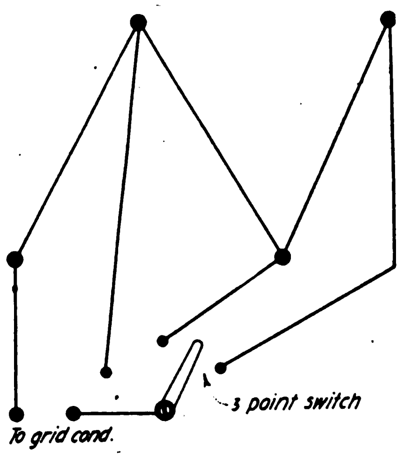


Figure 7—Diagram of connections for the three-point switch

The receiving system shown in figure 6 is not only exceedingly stable in operation but simple of adjustment and by proper selection of inductance at the antenna loading coil 1, at the tuning transformer 2 and at the loading coils in the grid and plate circuits, a point can be found where simple variation of the capacity of the condensers C-2 and C-3 will be sufficient to cover a wide range of wave lengths. In case near-by local power lines cause interference, the filament may be grounded to earth.

A Combination Spark and Buzzer Transmitter

By William Holladay

It is well known that the buzzer can be used for transmitting over distances up to about two or three miles. As it radiates a wave of the natural frequency of the aerial and of low decrement, and may be adjusted so as to give a 500 cycle tone, it makes a good substitute for the spark transmitter for inter-city communication. But very few amateurs are content to use a buzzer for transmitting and sooner or later they will choose a transformer for long distance communication. A transformer is not, however, well suited for short distances and the buzzer is the logical solution of such a problem. It is quite a job to change all the connections to the key, aerial and ground in order to change from the buzzer to the transformer, so I believe the accompanying circuit is the solution. The panel shows the arrangement of switches.

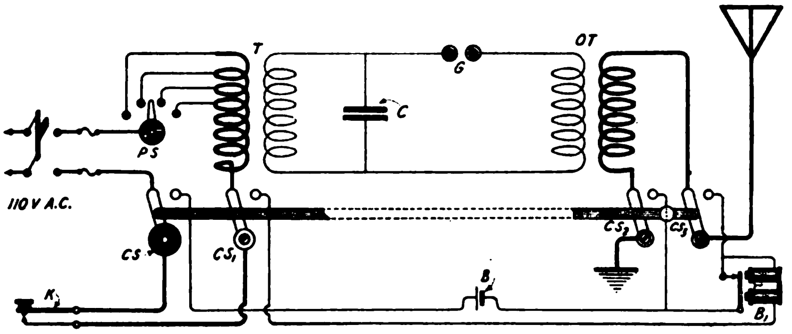


Figure 1—Circuit showing connections of switches in the combination spark and buzzer transmitter

Taking the circuit figure 1 with the switches CS, CS_1, CS_2 and CS_3, in the position shown, the current passes through the fused switch and through the reactance regulator PS, into the primary, through switch CS_1, to the key K and back to the line. The current induced in the transformer secondary charges the usual form of closed circuit, embracing the high potential condenser C, the rotary gap G and the primary of the oscillation transformer. The secondary is connected to the two remaining switches CS_2 and CS_3 to which are soldered leads to aerial and ground.

When the handle of CS is rotated, all the change-over switches are snapped to the right, and the buzzer circuit is used for transmitting. It will be seen that the current passes from the battery through the key by way of the first two switches, and the two contacts of the vibrator are connected to aerial and ground through the two switches on the right.

The switch panel shown in figure 2 should be of marble, bakelite, or other good insulating material, but for low powers well-varnished hardwood will answer the purpose. The two switches on the right, marked "G" and "A" should be about four inches long, made of copper bus-bar, with the contacts at least three inches apart. The two binding posts marked "110" are connected to the line and the "B" posts to the low voltage battery for running the buzzer. The two binding posts K on the lower part of the panel are connected to the key. It will be found better to solder the aerial and ground leads, and also the oscillation transformer leads, directly to the back of the switches. The panel should be about 15 inches long and 11 inches wide.

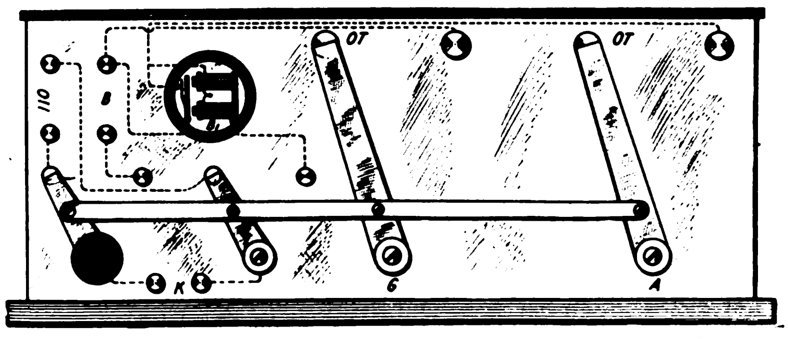


Figure 2—Panel showing arrangement and comparative sizes of switches

An Easily Constructed Oudin Coil

By R. C. Hitchcock

WHILE the amateur is obliged to abandon his radio transmitting set, he can easily construct a high frequency oscillator which may be energized by his transmitting outfit. Many interesting and startling experiments may be performed.

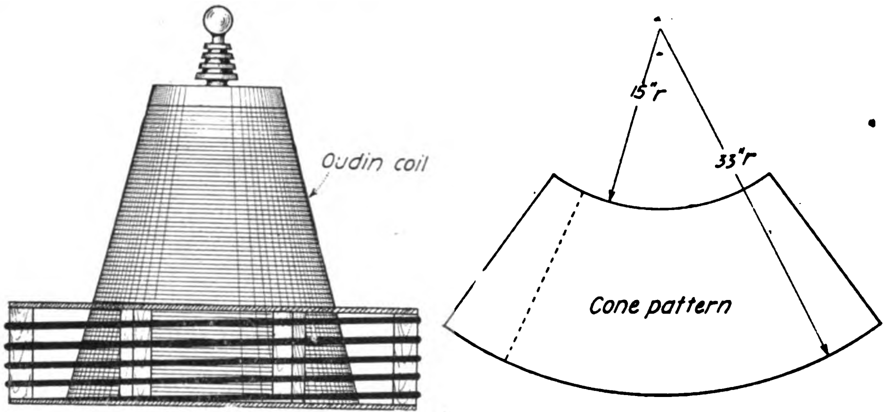


Figure 1—Constructional details of the Oudin coil

The coil shown in figure 1 has been successfully operated on a ½ kw. wireless transformer, using a glass condenser and straight gap. The straight gap gave high frequency sparks of greater length than a rotary gap.

The core for the secondary can be made of several pieces of cardboard, cut like the pattern and glued together, making a tube 18 inches long, 9 inches diameter at the small end and 18 inches at the other. Two wooden pieces are turned to fit the ends, and the assembly then mounted between lathe centers for winding. No. 26 wire is preferred and the turns should be spaced with a string which may be left on permanently. When the coil has been wound it should be painted with hot paraffine or some good insulating material.

The primary is wound on a six-sided figure about 24 inches outside diameter, depending on the width of the supports. Slots for No. 8 wire are provided, six turns being sufficient for the set under consideration.

An insulator, which may be turned of wood, is mounted on the secondary to support a brass ball from which the sparks are drawn.

The secondary and primary are grounded at one end and the other connections made as shown in figure 2.

Sparks drawn into metal objects held in the hand cause no shock whatever.

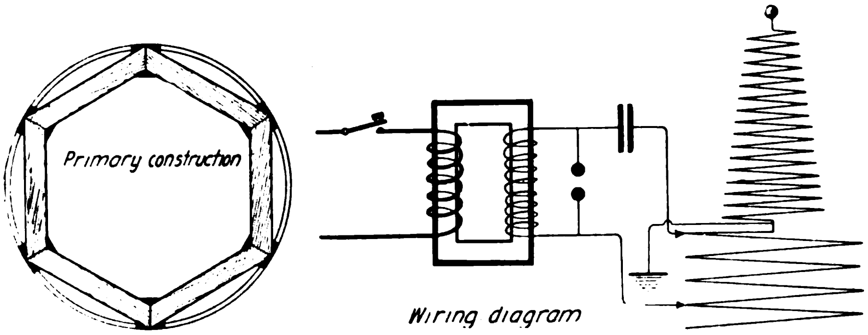


Figure 2—Primary construction and the wiring diagram

Code Practice Alternator for the Amateur

By C. J. Fitch

IT is certain that the amateur cannot expect to obtain genuine pleasure out of his radio apparatus unless he is skilled in sending and receiving. To acquire facility he needs a good code practice set. One particular way of generating artificial radio signals, doing away with the troublesome buzzer, is shown in the accompanying diagram. A small battery motor is rewound and connected in such a way as to produce a buzzing note in the head telephone. The details of construction follow:

The field is wound with No. 28 S.C.C. wire and connected in shunt to the armature. The armature coils are each wound with an equal number of turns of No. 26 S.C.C. wire. It is important that the coils be wound in the direction shown, otherwise the motor will not run. The three terminals connected at O are grounded on the rotor shaft. Connection from the battery to the shaft is made by a bronze spring wire rubbing in the groove of the small pulley mounted on the end of the shaft.

The theory of operation is as follows: When the armature is in the position shown, current flows from the battery to the + brush, through the coil C to the point O, through the coils A and B, which are connected in parallel at this instant, to the — brush and battery. The neutral wire OP will carry no current when both sides of the line are balanced. At the instant shown, however, the line is unbalanced, having two armature coils, A and B on one side and one coil C on the other. Therefore the neutral will carry the difference of current in the two sides and the current, in this case, will flow upward.

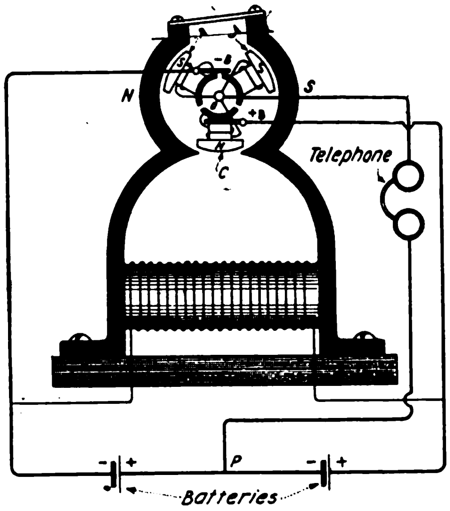


Figure 1—Showing construction and connections of the code practice alternator

The polarity of the armature and field poles when the above takes place is as indicated; the armature will rotate counter clock-wise. After the armature has rotated 60°, if the windings are traced out as before, it will be seen that two armature coils are in parallel on the side of the line which previously had one coil. In this position, the difference of current will flow down through the neutral, instead of up, as in the previous case. These reversals take place every time the armature rotates 60°, giving 6 reversals, or 3 cycles per revolution of the armature in the wire OP.

The object of the shunt field is to keep the system balanced. The series field may be used, but the current in the neutral wire will be a pulsating direct current.

No other equipment besides the motor is made use of.

Timely Advice on the Matter of Interference Between Amateur Stations

By J. E. Law, Jr.

THE amateur wireless enthusiast should exercise every means at his disposal to prevent interference. "Jamming," as wireless operators term it, may be due to any of the following causes: badly tuned transmitters; non-selective receiving apparatus; and non-observance by operators of the government regulations concerning the transmission of radiograms. Interference is not alone caused by transmitters radiating broad waves; the operator himself may lack the necessary operating skill to handle his apparatus intelligently.

One way of reducing the damping of the antenna oscillations is to select a transformer voltage suited to the set under construction, means being provided for careful regulation of its input. Abnormal spark gap voltages prevent quenching with consequent double wave emission.

The high voltage condenser should be immersed in oil to prevent brush discharge, for brush leakage is extremely detrimental to high efficiency and should be corrected before it punctures the dielectric.

The quenched spark gap is being used extensively by commercial and naval stations, and is today probably the most efficient type, since it can quickly quench out the primary oscillations before those in the antenna circuit react appreciably upon the closed circuit. The sparking surfaces of the series gap must be supported in a strictly parallel position and be kept clean. A motor blower or fan, such as is used on the Marconi panel transmitters, is required to keep the temperature at a safe value.

All leads connecting the closed circuit should be as short and as heavy as possible and should have no kinks or bends in them.

An oscillation transformer of the "pancake" type is the handiest for rapid change of wave length, but with all oscillation transformers two waves will usually be radiated if the spark gap does not quench properly and the coupling is too close. Single wave emission may be secured with any gap by reducing the coupling at the oscillation transformer. The antenna current will be reduced by this procedure. But the range of the station may be increased, because all radiation is taking place on one wave length. Careful attention to these details aid one in securing the desired sharp wave, i.e., a decrement of less than 0.2 as prescribed by law.

Nearly as important as the correct tuning of a transmitter is the provision of a selective receiving set. A vacuum tube detector permits sharper tuning than a crystal rectifier, and the use of litzendraht wire in the primary and secondary coils gives a minimum high frequency resistance. The tuning coils should be tapped so that the inductance may be varied one turn at a time. End turn switches should be used in order that turns not in use may be disconnected from those actually in the circuit.

In regard to the interference caused by the operator himself, I know it to be a fact that some operators do not always comply with the government regulations regarding the transmission of messages; when they have a message to transmit they persist in calling for a long period, even though transmission is in progress at the time. This interference is strictly *unnecessary*, with the possible exception of when urgent messages are to be transmitted. If all operators would observe the regulations governing the transmission of messages, such as the permissible wave lengths and the amount of power for a given distance, and moreover make more extensive use of abbreviations, general traffic would be dispatched with greater facility.

There are a few willful "air hogs" who want to get their messages through in a hurry and who have little respect for the other operators waiting for their turn to transmit. Let each operator, "Do unto others as he would have them do unto him," and there will be a change for the better.

An additional source of interference is the "spark coil menace," caused by "hams" disregarding every law concerning tuning, decrement, etc., and acquiring the habit of "sitting on the key."

If the government would amend the Radio Act so as to require all persons owning wireless sending stations of any power whatsoever to obtain licenses for their operation, these beginners would have some pride in their sets and strive to make them efficient. They would then realize that 200 meters means 200 *meters;* no more; no less!

Sometimes, relief may be had by paying them a friendly visit and urging them to join a wireless club where they can be taught the fundamental principles of wireless telegraphy.

Another way to decrease interference among these experimenters is to organize them all and plan out some sort of working schedule for testing periods and small talk, reserving other hours for long distance work and relaying, at which time no other transmission is to be allowed. As amateur organizations increase, doubtless some such schedule will become effective everywhere.

Ground Telegraphy

By Gerald Ehinger

THE theory of the ground telegraph is generally understood but it is not often used by amateurs. The underlying idea is to connect land line wires to earth at two points and utilize a buzzer at the transmitter station to impress variable electromotive forces upon the conducting earth. A fundamental diagram is shown in figure 1, where the transmitter includes a battery, key, and a high toned buzzer. At the receiving station, a telephone receiver is connected between two grounds as shown.

The power for the transmitter may be drawn from dry cells, storage batteries or a step-down transformer. A "break in" system is secured by connecting a condenser in the circuit as in figure 2. The working of the ap-

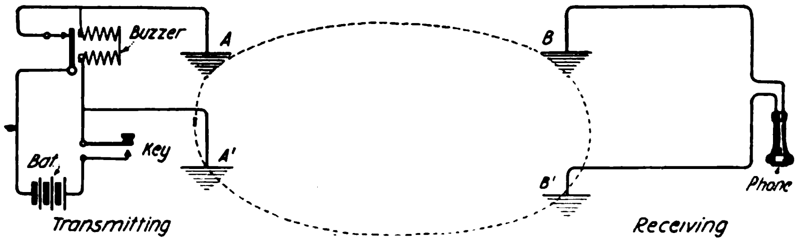


Figure 1—Fundamental circuit for ground telegraphy

paratus should be clear from the drawing.

The receiving telephone should have a low resistance; in fact, the lower the better. High resistance telephones can be used if connected to the secondary of a 1" coil (spark), the primary being connected into the circuit. A small spark coil may be used instead of a buzzer for transmitting purposes, but it is not as efficient.

Connections at the transmitter and receiver could be made to water and gas pipes, but the signals at the receiver will not be so strong as in the arrangement I have described.

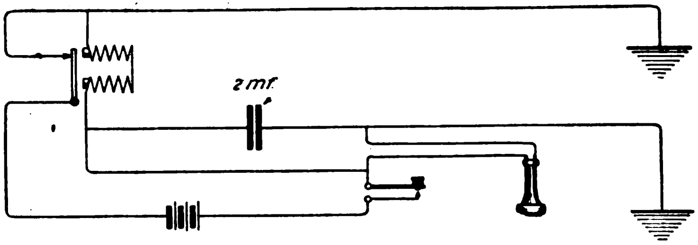


Figure 2—The "Break-in" system with condenser connected in the circuit

A Short Wave Receiver for the Amateur Station

By Carleton Howiler

I BELIEVE that the most efficient type of short wave receiver is that which employs variometers as the primary and secondary inductances. Hence the amount of inductance required to reach a wave-length of 200 meters is relatively small, and the losses in the variometers themselves are negligible.

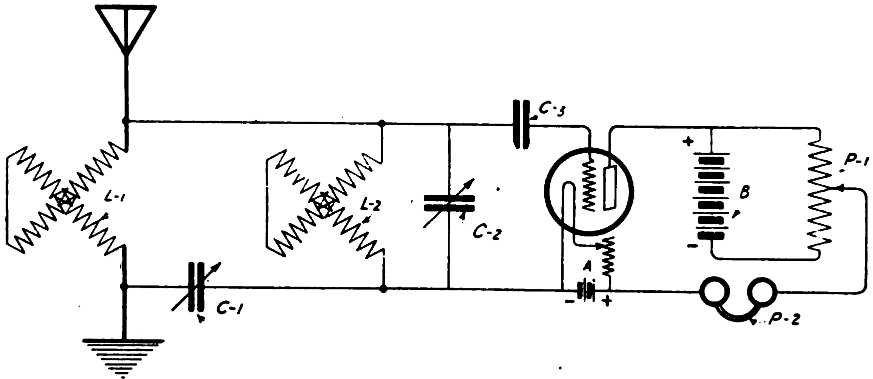


Figure 1—Circuit of the short wave receiver suitable for amateur stations

The diagram, figure 1, shows the circuit preferred for amateur use. L-1 is the antenna variometer and L-2 the variometer which acts as one of the tuning elements of the secondary circuit. It is shunted by the variable condenser C-2. In series with L-1 and L-2 is the variable condenser C-1 which has the effect of changing the coupling between the antenna and detector circuits. A small grid condenser C-3 of about .0005 mfd. is connected in series as shown. The plate circuit of the vacuum tube is energized by the battery B shunted by the potentiometer P-1, which may be of 3,000 ohms resistance. For additional amplification some part of the plate circuit may be placed in inductive relation to the grid circuit of the tube, but very good results will be obtained with the simple circuit shown.

The variometers are identical in construction. Each consist of two cardboard cylinders 1½ inches wide. The larger cylinder is 4½ inches in diameter and the smaller one 4 inches in diameter. Both are wound with the same number of turns of No. 26 S.C.C. wire.

I prefer to mount the variometers and variable condensers in opposite corners of a cabinet. The panel on which the vacuum tube detectors are mounted can be secured to the top, giving a very neat appearance.

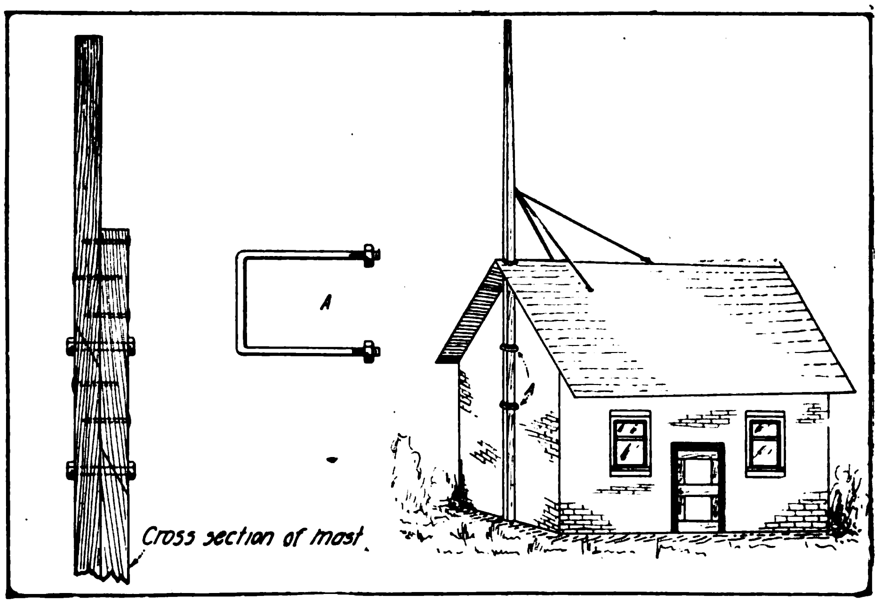
I am sure that with these few constructional details and a careful study of the diagrams, any amateur can readily build a set that will do far better work on short waves than the average amateur equipment.

An Aerial Mast on the Roof

THE amateur located in the country or a small town may be interested in the design of an aerial mast constructed as shown in the accompanying drawings. It will be noted that a hole is cut in the roof of the building through which the mast enters and that the mast is clamped to the side of the building by means of two iron rods of the shape shown in the figure at A, which are threaded at both ends to take a bolt.

The mast may be put together in sections, one at a time, and slid up through the holding clamps. By using pieces of two by four lumber 16 feet long, a very serviceable mast is obtained. Two or three 16 foot pieces will be sufficient for the average amateur aerial mast.

HENRY KLAUS, *Illinois.*



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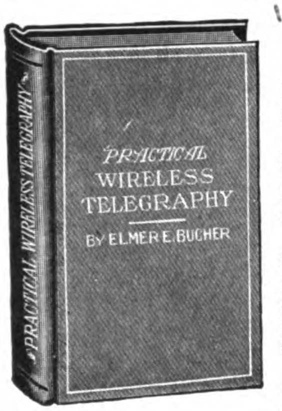

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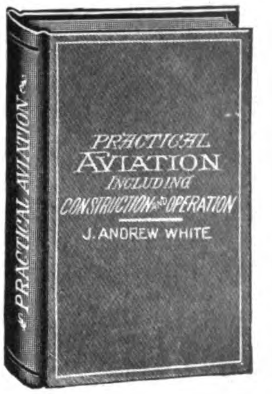

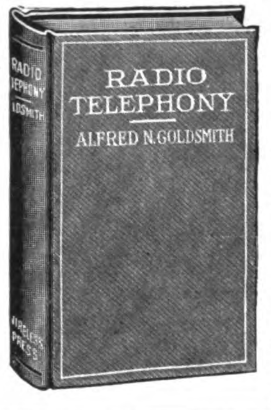

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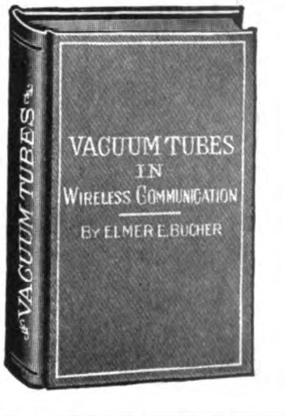

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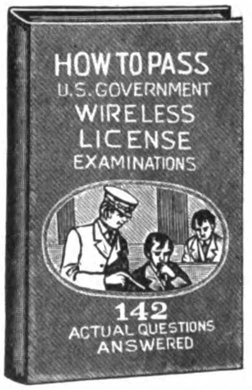
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The friction in the claw and ball joints is increased or decreased by means of a screw 9 acting upon the ball through the bottom of the cup. The crystal is held between the jaws of a spring clamp 2 mounted on the ball 4. Experimenters possessing the facilities for the construction, will undoubtedly find this a very convenient and practical detector stand.

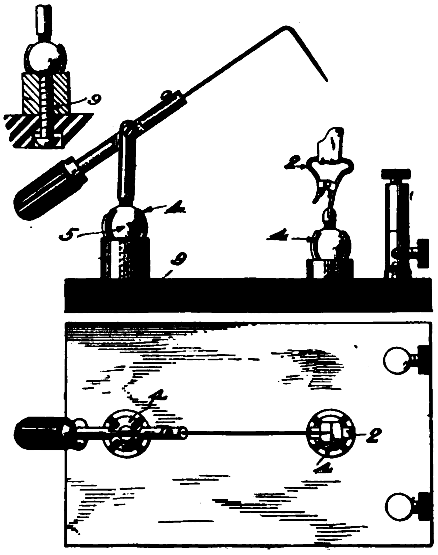

Figure 1—Showing construction and assembly of the cat-whisker detector stand

Amateur War Work

I AM a non-commissioned officer in the radio branch of the U. S. Signal Corps and have had many an opportunity to see the value the radio operator has been to the Army in France. The best of the signal personnel are former, or pre-war, amateurs who operated amateur stations and enlisted like myself when the war broke out.

A little incident in which I took part during the great drive we made against the Hun will show why the radio amateur should be encouraged.

One dark night we could not raise 4 - - -, who was located about a half mile forward of us. After calling several times we decided to go and see what was wrong. Station 4 - - - was manned by radio men who got what radio experience they ever had in the Signal Corps. To reach them we had to drive a motorcycle, another lad and I, over a road which was undergoing the worst shelling by the Huns it ever had. But we arrived O. K. We were using a sustained wave transmitter of the bulb type and the high tension battery was made up of a large number of 40 volt storage batteries. Upon examination of the Station 4 - - - set we found this battery circuit open.

We of course put the station working in short order. The point of the incident—only one of many incidents —is that the amateur radio men have shown themselves far superior to those who were taught wireless in the Service. And while we were still in uniform and not able to make an organized protest against Congressional action, they tried to wipe us off the map. Fine recognition of valuable service well rendered. I am sending these few lines to the N. W. A. by request of the amateurs in our outfit, which number up pretty high.

Corporal E. J. Atkinson (*formerly 1QV*), *302nd Field Sig. Bn., A. E. F., France.*

Safeguarding Our President By Radio

EXTRAORDINARY efforts were made by the U. S. Navy Department to maintain continuous radio communication with the U. S. S. George Washington, carrying the President of the United States and his official party to France. As is well known, the vessel was convoyed by the U. S. S. Pennsylvania, which was equipped with powerful wireless transmitting and receiving apparatus. Four high power undamped wave transmitting land stations were employed to transmit to and receive from the George Washington, the Annapolis arc set transmitting on 16,900 meters, the arc set at Tuckerton, N. J., on 9,200 meters and the Marconi radio frequency alternator set at New Brunswick, N. J., on 13,000 meters. The Government high power station at Lyons, France, transmitted on 15,500 meters.

The battleship Pennsylvania's radio equipment consisted of a 30 kw. arc transmitter, which was used for transmitting messages to the United States and France on the wave length of 3,600 meters; also one 10 kw. quenched spark transmitter working on 600 and 952 meters, which was employed for communication with low power land stations; a short range radio telephone transmitter working on 297 meters, and one vacuum tube radio telegraph set transmitting on 450 meters. The latter was used for communicating between the U. S. S. George Washington and her convoy, the Pennsylvania. The Pennsylvania worked United States stations up to 2,500 miles and communication was established with Lyons, France, before the Pennsylvania was out of range with the United States.

The Pennsylvania's radio cabin was fitted with six receiving booths which were able to receive at eight different tunes simultaneously as follows: One booth was on constant watch for the 297 meter telephone signal and another booth guarded the 450 meter vacuum tube transmitting set for communication with the Pennsylvania. Another operator on a separate receiving set stood by on 4,000 meters, which is the standard arc calling tune; the fourth receiver guarded Lyons' wave length of 15,500 meters and the fifth guarded Tuckerton's tune, 9,200 meters. The sixth set was kept on constant watch to pick up signals from Annapolis or the Marconi New Brunswick station at 16,900 and 13,000 meters respectively. Another operator with a distinct receiving set and antenna guarded 600 and 952 meters. The principal receiving station in the United States was that located at Otter Cliffs, Me., but other stations were also kept on watch for the reception of signals. On the other side, the reception of signals was effected at Lyons, France.

Suggestion for Prize Contest, July Issue Wireless Age

We will pay the usual prizes of $10, $5 and $3, in addition to our regular space rates, to the three contributors who send us the best manuscripts on the following subject:

"What are the relative merits of the regenerative vacuum tube receiver and the cascade vacuum tube amplifier for radio reception at amateur wave length?"

The radio equipment on the U. S. S. George Washington consisted of a low power spark transmitting set, a 16,900 meter long wave receiving set, one 600 meter spark receiving set, one short wave radio telephone transmitting and receiving set and one vacuum tube 450 meter telegraph transmitting and receiving set.

The George Washington was able to take down messages transmitted from the Annapolis or New Brunswick station and at the same time keep an efficient watch on the wave length of 600 meters, intercept commercial signals, emergency signals or messages transmitted by radio telephone or vacuum tube transmitters, simultaneously.

The messages intended for the George Washington were received principally on the Pennsylvania and relayed to the George Washington by means of the wireless telephone and vacuum tube telegraph set, simultaneously.

A Simple Method of Tuning the Amateur Transmitter

SINCE the declaration of peace seems a short time off and the whole tribe of amateurs are looking forward to the day when they will be able to revert to the peaceful pursuit of radio telegraphy, the following method of tuning the transmitting apparatus to the required wave of 200 meters will, because of its simplicity, and because of the fact that no wave meter is required, appeal to many suburbanites and less wealthy experimenters, who are unable to procure the use of a calibrated instrument:

An exploring coil of optional dimensions (six or eight turns of No. 20 wire around a short cardboard tube having a diameter of 3 or 4 inches, is satisfactory) is inserted in series with the secondary of the loose coupler of the ordinary short wave receiving circuit. Using a minimum degree of coupling, the receiving apparatus is tuned to the signals of a station having a known 200 meter wave. When these adjustments have been made as accurately as possible, the loose coupler secondary is moved from inductive relationship with the primary, in order to avoid mutual inductance between the two, which would affect the accuracy of the readings.

The complete secondary circuit of the receiving apparatus now forms a wave meter, permanently adjusted to a wave length of 200 meters, the telephones being employed to find resonance as in a standard wave meter. The transmitting apparatus may now be tuned by any one of the commonly used methods. Perhaps the most satisfactory method for our purpose is to excite the aerial by means of a small buzzer, connecting the buzzer contacts to aerial and ground respectively. The buzzer is set into operation, and the exploring coil of the wave meter is brought into juxtaposition with the secondary of the oscillation transformer, so that the buzzer signals are barely audible. The inductance of the oscillation transformer is changed until maximum response is noted in the telephones. The transmitting set next is put into operation and, using a small value of coupling, the oscillation transformer primary inductance is changed until the aerial ammeter or pilot lamp shows a maximum reading. The critical value of coupling to be employed may be ascertained from the other fellow, who can inform you when your wave becomes too broad.

SGT. MAJ. CHARLES MANLEY—*Amer. Exped. Forces, France.*

Contest Winners for June

The April subject for discussion was: "Which of the two following types of wireless transmitter do you consider to be the most practical for amateur use, namely: the panel type or the isolated instrument type?" Prizes have been awarded to the writers of the following articles.

First Prize—The Panel Transmitter Versus the Isolated Instrument Type

TO my mind, the question as to whether the panel or isolated instrument type of transmitter is the more practical is not difficult to answer. While it cannot be denied that the isolated instrument type has given good results and that some amateurs will continue to use it after the ban is lifted, yet there can be no argument against the superiority of the panel transmitter.

A particular advantage of panel mounting is the reduction of the length of the leads in the oscillation circuits. This is a vital factor when we take into consideration that the maximum capacity of the condenser of the amateur transmitting circuit can not exceed .008 mfd.; for otherwise, the wave length of the closed oscillation circuit will exceed the government restriction. In addition to the lead reduction advantage, the panel transmitter permits centralization of control. This is of especial importance when rapid changes in the circuits are to be made, such as changing the radiated wave length. Then, too, the panel set takes up less space and it presents a much better appearance. Any amateur will agree with the latter conclusion after once having seen some stations in which the various instruments, such as the transformer, condenser and spark gap are scattered around the floor. Such haphazard installation is not only uncalled for, but it displays ignorance on the part of the owner in regard to the fundamental requirements of an efficient station.

It is often argued that the instruments of the isolated type of transmitter are more accessible for repair; but to my way of thinking, if the panel type is properly designed it is just as accessible as any other type.

I like particularly the transmitter

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described by Mr. Zahorsky in the April issue of The Wireless Age, but I am inclined to believe that a neater set would result if the experimenters would mount their apparatus behind the panel as is done in standard Marconi sets. While on this point, I would urge that amateurs study the good points of the Marconi panel transmitters described in "Practical Wireless Telegraphy."

The experimenter should realize that commercial companies have sifted this matter down to the last detail and their panel designs are undoubtedly the result of extended experience. Why not make good use of that experience?

The writer once designed a transmitting set which consumed one-sixteenth kilowatt; the instruments, comprising the complete set, were arranged on a table in as efficient a manner as was possible. Later, these instruments were mounted on a panel and increased range of transmission was secured. This was undoubtedly due to the use of short connecting leads, particularly in the spark gap circuit.

I do not think it advisable to suggest a particular design for an efficient panel set, for I believe it to be impossible to put forth suggestions that would be acceptable to all; besides which, the arrangement of the apparatus on the board would depend upon the type of transmitter used. As far as I am personally concerned, the panel set is the only type to which I would give serious consideration.

N. W. Lockwood, *Pennsylvania.*

Second Prize—Panel Versus Isolated Instrument Type of Amateur Radio Transmitter

Unlike radio receiving outfits, the hook-ups for transmitting outfits are limited, and are practically on a par, so far as the efficiency of the set is concerned. The amateur's sending set generally consists of the following instruments: key, step-up transformer, condensers, spark-gap, oscillation transformer, and usually a hot-wire ammeter. There are but two schemes in general use (see figures 1 and 2) for connecting these instruments, and they are practically identical in regard to efficiency.

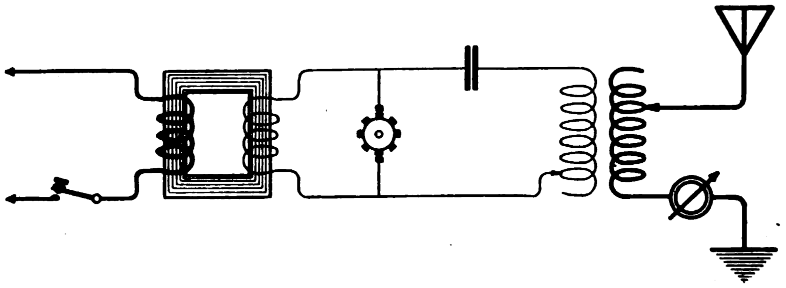

Figure 1—Standard hook-up for amateur panel transmitting set

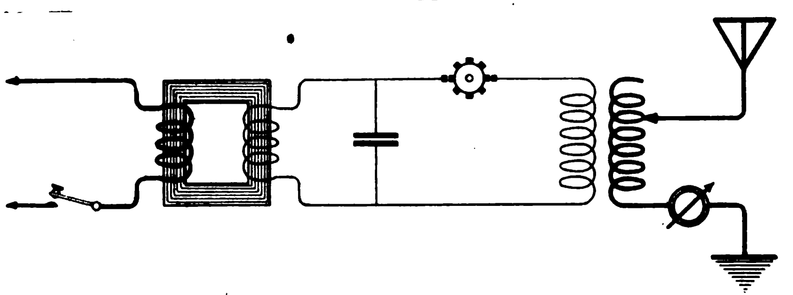

Figure 2—Another form of figure 1

The first factor for the amateur to consider in the design of his transmitter is to arrange and design the instruments so that the radiated wave length will comply with the laws governing amateur or experimental transmitting stations. To keep the wave length within the restrictions imposed by law, the shortest possible connections should be used. Next in importance is the insulation problem. Leakage is the source of large losses, but it can easily be prevented.

Now for the particular advantages the panel type possesses over the isolated instrument type: It is not necessary or desirable to isolate the several instruments in order that different hook-ups may be tried, because they have all been tried, and the best ones appear in figures 1 and 2. It is a well known fact that it is a much easier matter to make short connections when the instruments are mounted on a panel. Good insulation can be had in either method. I have

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seen panel transmitting sets in which nearly all connecting wires, binding posts, etc., were imbedded in an insulating compound, making them weather and "fool" proof. With regard to the comparative ease of operation of the two types, they are on a par, and depend entirely upon the forethought used in installation.

Finally, I am sure the readers of THE WIRELESS AGE will agree that, as a rule, the panel type amateur transmitter, although slightly more expensive, has a decided advantage in neatness and appearance as compared with the old fashioned, isolated instrument type.

L. W. VAN SLYCK, *Michigan.*

Third Prize—The Panel Transmitter

AMATEUR transmitting sets may be divided into two general classes: The panel type, in which the instruments are arranged in a compact, systematic manner and the isolated instrument type, in which they are scattered about without regard to over-all efficiency. For the amateur who wishes to get the best results from his sending set, the panel type is by far the most desirable of the two. The efficiency of a transmitting set will be remarkably increased by panel mounting, principally because of the reduced length of the leads in the oscillating circuits. In addition, this construction provides better insulation.

Arrangement of the instruments, one above the other, in logical order, permits short leads which need not cross each other and in the matter of insulation each separate instrument has its own rack, thus doing away with leakage or cross induction. Thus the panel transmitter affords a remedy for the two greatest defects of the isolated instrument type.

A most important factor in operating sending apparatus is the assurance of safety to both the operator and instruments. The panel, because of the small floor space it requires, can be placed in a convenient position where it will not injure the receiving instruments. The only wires required to operate the panel at any distance are those leading to the key and to the rotary gap switch. In this set, moreover, the apparatus, situated behind a protecting panel, is in no danger of being jarred, upset, broken, or put out of adjustment as may be the case when the apparatus is spread all over the room. And not only are the instruments and their connecting wires removed from the operator's very elbow, but further, all wires are mounted behind the panel, eliminating the danger of shock to any one while sending.

Compactness, a valuable quality in any set, is a feature of the panel transmitter. The manner of arranging the instruments one over the other naturally makes a compact set. Indeed, a panel equipped with ordinary amateur apparatus can easily be mounted in a space, 4 feet by 3 feet by 2 feet. This compactness facilitates quick adjustment and renders the set portable. In this feature, the panel has a great advantage over the old type, in which the willy-nilly arrangement of the component parts makes adjustment difficult and quick moving impossible.

While not important in respect to efficiency, an always outstanding feature of a transmitting set is its appearance. In a panel transmitter the orderly arrangement of the apparatus gives a pleasing effect. In some types of panels all of the instruments are back of the panel itself, while in others, they are on the front. There are numerous models of each type, which have been described in previous issues of THE WIRELESS AGE, all of which would give a station a distinctive appearance.

Now, as to the objections to the panel transmitter: Many amateurs have the idea that such a set is large, expensive and distinctly professional. Others think that it is difficult to operate. In the first place, a panel set is not big and cumbersome. I have never seen a diagram for a panel which was larger than 5 feet from floor to top, 3 feet across the front and 3 feet from extreme back to front. In fact, one of such dimensions is unusually large. So, if the amateur can stand upright in his wireless room, he has more space than is needed to erect a panel. It would occupy, if of usual dimensions, about 6 square feet, that is, approximately 3 by 2 feet, whereas the old type transmitter requires usually double or triple that amount of space.

The apparatus used in a panel set is exactly the same as that of the ordinary amateur set. To change to a panel set, it is only necessary to transfer the instruments from their present isolated locations to the well-arranged shelves made for them in the panel. The only added expense is in making the panel, an easy task for any amateur handy with tools. This light cost is more than made up for by the efficiency and pleasing appearance of the finished panel.

Backed by the experience and opinions of some of the foremost authorities on wireless in this country, I strongly advise and in fact urge amateurs to discard the old method of isolated arrangement, and to place their apparatus in a vastly more practical form, i.e., build a panel transmitter.

HARRY HEMPHILL, *New Jersey.*

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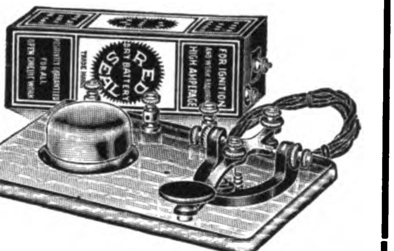

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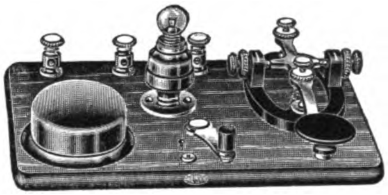

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Pittsburgh Club Resumes

A CAMPAIGN for membership has been instituted by the Pittsburgh Radio Club, an organization which was formed some time before the war. Regular meetings will be held at stated intervals, where the members can get together and discuss the various problems in which they are interested, arrange relay systems, tests of equipment and other activities. Interesting talks will be scheduled on such subjects as the construction of some particularly efficient piece of apparatus, wave-lengths and tuning, description and explanation of any new and interesting radio apparatus, wireless legislation and amateur experiences in the service during the war.

Another and very important function of this club will be that of teaching the International Morse (Continental) Code to all those who are not now as proficient as they would like to be. Burton Williams, president of the club, was in the Signal Corps, U. S. A., and later was Government instructor at the school for training radio operators installed in the Carnegie Institute of Technology.

It is proposed to install complete sending and receiving equipment in the club rooms for the benefit of all the members, the present plan being to use two aerials; one long one for receiving, and a 200 meter aerial for sending. The equipment will also include an omnigraph and buzzer practice sets for code practice. It is further proposed to subscribe for the leading wireless magazines and endeavor to have a library section.

Invitations to seek membership are issued to all amateurs. C. E. Urban, 26 Watson Boulevard, N. S., Pittsburgh, Pa., is secretary of the club.

Regarding Restrictions on Amateur Stations

THE radio stations of the United States may be classified into three types, namely; commercial (including ship and shore stations), government and amateur stations. The first two types are essential to the nation for commercial and military reasons. The amateur stations are extremely useful to the country largely on account of their educational influence on the future wireless operator.

In the early days, because of the comparatively small number of radio stations in operation, the matter of interference was a negligible factor, but with the rapid increase of stations during the last ten years, interference has become such an important problem as to require regulation. As all radio men are aware, the authority to regulate the wave lengths and power employed has been delegated to the Department of Commerce.

In my opinion, the only way to eliminate interference is to classify stations according to their importance and have them operate in a region of defined wave lengths. The amateur has been allotted any wave length up to 200 meters and in exceptional cases wave lengths in excess of this figure. The principal objection to some amateur stations is, that they are not carefully constructed and properly tuned and as a consequence they radiate what is termed a "broad wave." This, of course, is in violation of the wireless statutes and creates a great deal of unnecessary interference. In some cases the emission of a broad wave is due to the use of the direct aerial connection, that is, the spark gap is placed in series with the antenna. If the authorities would compel the use of coupled circuits, this difficulty would be largely eliminated. In fact, in the writer's opinion, if regulations were enacted restricting the use of broad waves, the actual wave length used by the amateur, particularly in certain localities, would make little difference.

I would suggest that amateur transmitting stations be divided into two classes. In the first class we would place such stations as would do purely local transmission; and in the second class, those who intend to transmit over great distances. I would urge that the amateurs in the first class be permitted to operate in 150 meters and those in the second class on wave lengths up to 250 meters. If this policy was adopted, the local amateurs would not interfere with those doing long distance work. Furthermore, those in the first class might be allowed to operate their apparatus without obtaining a license provided they will conform to the regulations concerning wave length, power, etc.; but those entered in the second class should be required to pass an examination covering their proficiency in the telegraph code, technical knowledge, etc.

Amateurs in the first class would be limited to spark coil transmitters or alternating transmitters of equivalent low power. Those in the second class should be allowed to use power inputs up to 1 kw. Amateur stations in the vicinity of commercial or naval stations should be limited to the same power input as in the past.

It is the moral duty of every amateur wireless operator to do everything in his power to prevent interference with commercial or government stations and there is no reason why he should not take a similar attitude toward amateur stations. The experimenter also should be educated to make use of variable power inputs and to use no more power than is necessary to cover a given distance.

J. C. Morris, Jr.—*Louisiana.*

Vibration as a Basis of Invention

THE person who would give to the world some great invention must not deceive himself into thinking that he can do it by creative processes. It is not our function to create. It is our province only to adapt the laws and forces already in existence to our needs. The process is really a relative rather than a creative one. The laws and forces are here. It is our work to relate ourselves to them. One cannot build a machine that will do anything. He can only construct a mechanism through which the already existing laws of nature can operate.

Another mistake apt to be made by the amateur, and one which will lead him farther away from instead of nearer to success, is the entertainment of the notion that a wonderful mechanism must necessarily be complex. The wonderful thing about nature, after all, is its simplicity. The mechanism which is to establish a point of contact between us and a force of nature must be as simple in its principle as the force itself.

The notable thing about almost any of our great inventions is the simplicity of their design and operative principle. After observing the action of any of them one is quite apt to turn away and inwardly remark that he could have done the same thing himself if he had only thought of it. Of course, the chief approach to any notable achievement is the matter of thinking of it. Most of us do not think of these things, and the reason is often the fact that we are looking for something complex when the real principle is very simple.

The problem of the would-be inventor or discoverer, then, is not one of adding something to the universe as it stands. His work is to ponder the forces that have long operated and the laws by which they have operated, and then relate his work to some one of them. One of the chief of these, and one upon which some of our notable inventions have been based, is the universal fact of vibration.

The first great inventions which are based upon the vibration theory were made long before any of us were born and each of us has been given a free sample of both. One is named the eye, while the other is known as the ear. So far as that is concerned the work of the actual nerves at the surface of the skin is based upon the same principle.

The other day in a medical laboratory I was examining a dissection of the human head made with a view to showing the nerves in their relation to the spinal trunk and to the brain. The brain had been removed down to where its base rests upon the spinal stem. I was not so much interested in the countless fibers running off from the entire length of the spinal cord nearly so much as the two sets of nerves which have to do with seeing and hearing. Off from the spinal stem, just below the base of the brain, two large nerves ran forward to the eyes, and two other large ones ran aside to the ears. These were the optic and the auditory nerves, respectively.

These are the means which the Ruling Genius of the universe has established by which the person may maintain his contact with the outward world. One of these sets takes up vibrations and reports them in terms of light. The other takes vibrations and reports them in terms of sound. The two sets look almost precisely alike. The means by which they are made to distinguish vibrations into these two different forms of interpretation remains a mystery, unless it be that they are made sensitive only to given lengths and types of waves.

The eye was the first camera, and the inventor of the photographic process necessarily had to base his work on precisely the same principle. A

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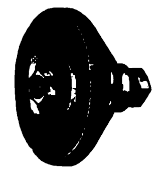

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sensitive surface had to be provided; a means had to be established whereby it might receive and be affected by ether vibrations of given lengths; then the result, which in the case of the eye is so temporary, had to be chemically fixed and thereby rendered permanent.

The phonographic process is related to the vibration theory of sound just as the photographic process is based upon the wave theory of light. A phonographic record is simply the photograph of a sound. A surface had to be provided which was capable of receiving the record of the vibrations which make a given sound. The means had to be provided by which they could be permanently recorded there. Then a mechanism capable of reproducing them made the phonograph complete. The same effect was produced upon the ear as would have been produced by the original vibrations themselves. Thereby the thing which is fleeting and temporary to the ear was rendered more or less permanent. These two inventions proved once and for all the truth of the theories on which they were based.

Telegraphy and telephony, both ordinary and wireless, are likewise based upon phases of the vibration principle. Each in its day has been revolutionary. We, are, however, only upon the threshold of achievement in these vibratory means of communication. Each is simple, when once achieved, because each is based on ordinary and everyday laws of nature. Those who are improving upon the processes already established are not those who are trying to find different paths. They are those who are seeking a closer acquaintance with natural laws as they are, and who are seeking better ways of relating ourselves to those laws. can only improve upon their use.

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any limit to the good they can be made to do when intelligently turned to worthy purposes.

Probably the statement of the scientist mentioned above was, after all, only a part of the truth. Someone has said that one cannot move his finger without displacing the elements of the universe all the way to the farthest star. Vibration is not only here but everywhere. It carries light to us from so far that years are required for the journey. It is not inconceivable that it might be made to do the same with sound.

Certainly it could be made to do the same with ideas if two conditions could be fulfilled. First, there would have to be living and intelligent beings elsewhere in the universe. Second, there would have to be a common code or basis of interpretation between ourselves and them. About the first we do not know. As to the second, no one yet sees how to accomplish such a thing. Archimedes could have moved the world with a lever if he had only had a place to stand, but of course he did not have it, so the possibility was spoiled. The principle of the lever, however, held just as good as though the impossible condition could have been fulfilled. Likewise, the law of vibrations would permit of a system of wireless out into the reaches of space. The difficulty is not with the law.

Nature probably holds some provision for our every want. We need only to establish the means by which she can deliver her gifts to us. The universe thrills with life and action. Out of its heart-throbs we shall be able to gather many a blessing.

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Queries Answered

Answers will be given in this department to questions of subscribers, covering the full range of wireless subjects, but only those which relate to the technical phases of the art and which are of general interest to readers will be published here. The subscriber's name and address must be given in all letters and only one side of the paper written on; where diagrams are necessary they must be on a separate sheet and drawn with India ink. Not more than five questions of one reader can be answered in the same issue. To receive attention these rules must be rigidly observed.

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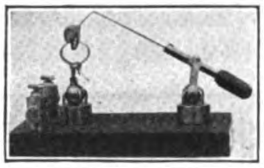
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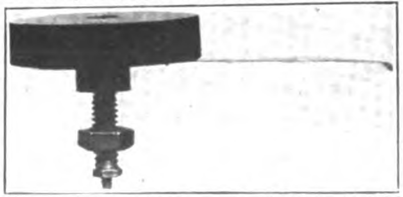
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chanical contrivance within the station. A four-stage resistance coupled amplifier constructed in accordance with the description in the April issue of THE WIRELESS AGE, or in accordance with the several circuits shown in the recently revised text book "Vacuum Tubes in Wireless Communication," will permit reception of short wave lengths over considerable distances. The directional characteristics of these frames permit a considerable amount of interference to be eliminated. Such an aerial, in fact, constitutes a direction finder and will indicate the general direction of an advancing wireless telegraph wave.

* * *

J. A., San Juan, Porto Rico:

Perhaps you misunderstood the reply to the query in the September, 1917, issue of THE WIRELESS AGE. Loading coils should be connected in both primary and secondary circuits of the long wave receiving tuner mentioned in that query. Unless multi-layered primary and secondary coils are used the tuner would be too clumsy to be manipulated conveniently.

The inductance required in the secondary circuit of a receiving tuner for a given wave length can be readily calculated by Nagaoka's formula, shape factor curves for which are given in the text book "Practical Wireless Telegraphy." To determine the required value of inductance you must first decide on the maximum shunt capacity to be used across the secondary circuit. Then use the following formula:

$$L = \frac{\lambda^2}{3552 \times C}$$

where C = capacity of the condenser in microfarads, λ = wave length in meters and L = inductance in centimeters. The dimensions of a coil to satisfy the inductance found by the above formula may be determined from Nagaoka's formula in "Practical Wireless Telegraphy" or Lorenz's formula in "How to Conduct a Radio Club."

In regard to the condenser of one microfarad capacity: You will find it less expensive to purchase one of this capacity than to construct it. Doubling the area of the surface of the condenser will double its capacity, provided the dielectric remains the same. Any electrical supply house can probably furnish you with one of these condensers.

Galvanized iron wire will function as a receiving antenna, but copper wire is better. Platinum wire can be obtained from any electrical supply house.

Regarding the dimensions of the buzzer coil for exciting the secondary circuit of the receiving tuner: If you desire to employ an aperiodic excitation circuit, a dozen turns of annunciator wire wound on a spool 2 inches in diameter, will be sufficient to set the detector circuit into excitation.

* * *

J. P. S., Buffalo, N. Y.:

If your first inquiry in reference to the best amateur antenna refers to wireless transmission at amateur wave lengths, the flat top portion should not be more than 120 feet in length; otherwise, the fundamental wave length will exceed 200 meters. A "T" aerial of the same dimensions as the "L" type will have a lower fundamental wave length. To change from an "L" to a "T" aerial often proves a very convenient means of reducing the fundamental wave length below 200 meters.

In reply to your second query, regarding the relation between the power of a transmitter and the radiated wave length: You should know that many variable factors enter the case. A high power transmitter necessarily radiates at long wave lengths on account of the large condenser required to absorb the output of the high voltage transformer.

In reply to the third query: When a wireless transmitter radiates waves of high decrement it radiates a wave of such characteristics that it will set into excitation receiving sets which are not sharply tuned to the radiated wave.

The Weagant static eliminator is feasible for amateur working but requires rather large aerials. Each loop should be about 350 feet long and the plane of the antennae should preferably point in the direction of the transmitting station.

* * *

J. W., New York City:

You are quite right in assuming that an undamped wave receiving set which employs the heterodyne principle radiates electromagnetic waves. If one of your amateur friends possesses a similar set there is no reason why you cannot establish wireless telephone communication over one-quarter mile, as you suggest. In fact, the writer, with an 8,000 meter set adjusted for undamped reception has communicated telephonically with another amateur station adjusted to the same wave length over a distance of 1¾ miles. You would obtain far better results with the circuit you have shown by connecting the microphone in some part of the grid circuit. Of course you cannot expect to obtain maximum efficiency in undamped wave transmission with a receiving set because of the resistance of the tuning coils.

In the matter of wireless telephony, your attention is directed to the last chapter of the newly revised edition of "Vacuum Tubes in Wireless Communication." Complete details of oscillating tube wireless telephone transmitters that will prove highly satisfactory for amateur communication are given. Also note the article by M. W. Sterns in this issue of THE WIRELESS AGE.

It is practical to connect several oscillating bulbs in parallel. Good results will be obtained with bulbs of identical operating characteristics.

The presence of a ground antenna within 40 feet of your receiving antenna will effect the latter's resonating qualities and change its wave length. Whether or not it will weaken the signal in the receiving antenna is a matter governed by many variable factors and the facts can best be determined by experiment.

The matter of amplification in vacuum tube circuits is an elusive measurement, from the amateur's standpoint. Just how much a set will amplify depends upon a number of conditions which have to be taken into consideration. One thing you will observe in a cascade amplifier is, that its amplifying qualities are most discernible in the reception of weak signals. Strong signals will not be much louder than with a single bulb.

* * *

H. H., Atlantic City, N. J.:

In view of the local conditions surrounding your station, it is believed that an antenna built in accordance with the sketch you have sent in is the best possible design. It is often very difficult to remove the induction from arc light circuits and trolley wires. One method of getting rid of this interference is to erect a single wire aerial 30 or 40 feet high in close inductive relation to the power wires and couple this circuit inductively to the secondary circuit of the receiving transformer. By this means, the the interfering currents in the receiving antenna can sometimes be brought into nearly opposite phase with those induced in the special antenna, resulting in almost complete annullment. The diagram you show for a receiving set is correct. Special advice on this matter is not necessary. THE WIRELESS AGE has published many diagrams applicable to amateur work.

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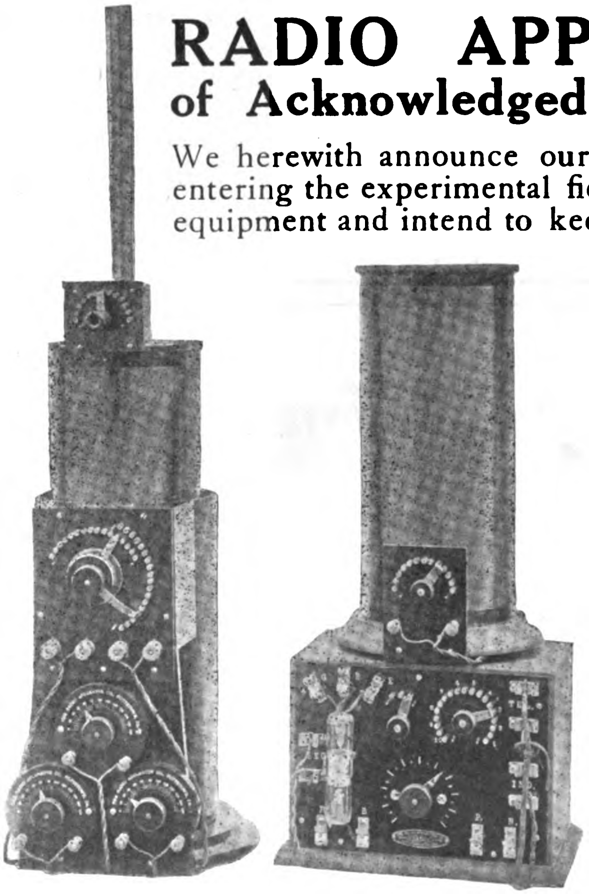

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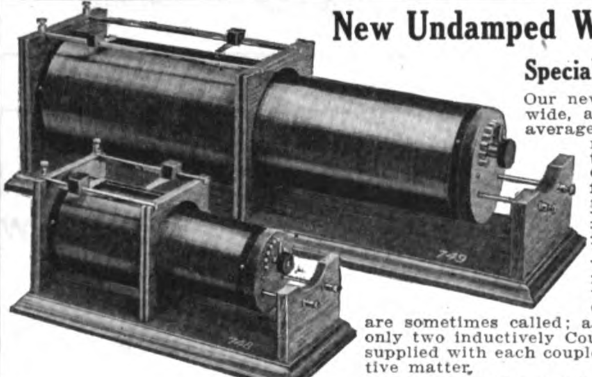

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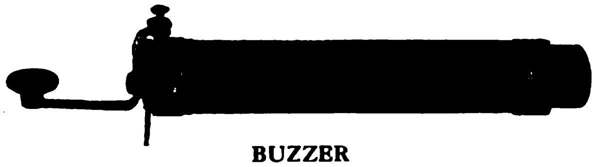

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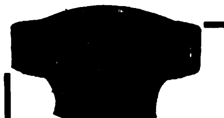

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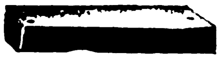

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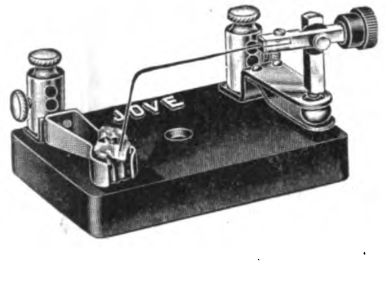

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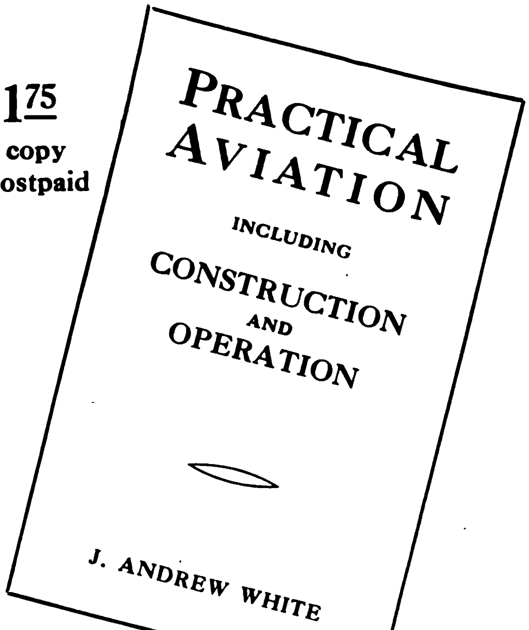

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Volume 6 Number 10

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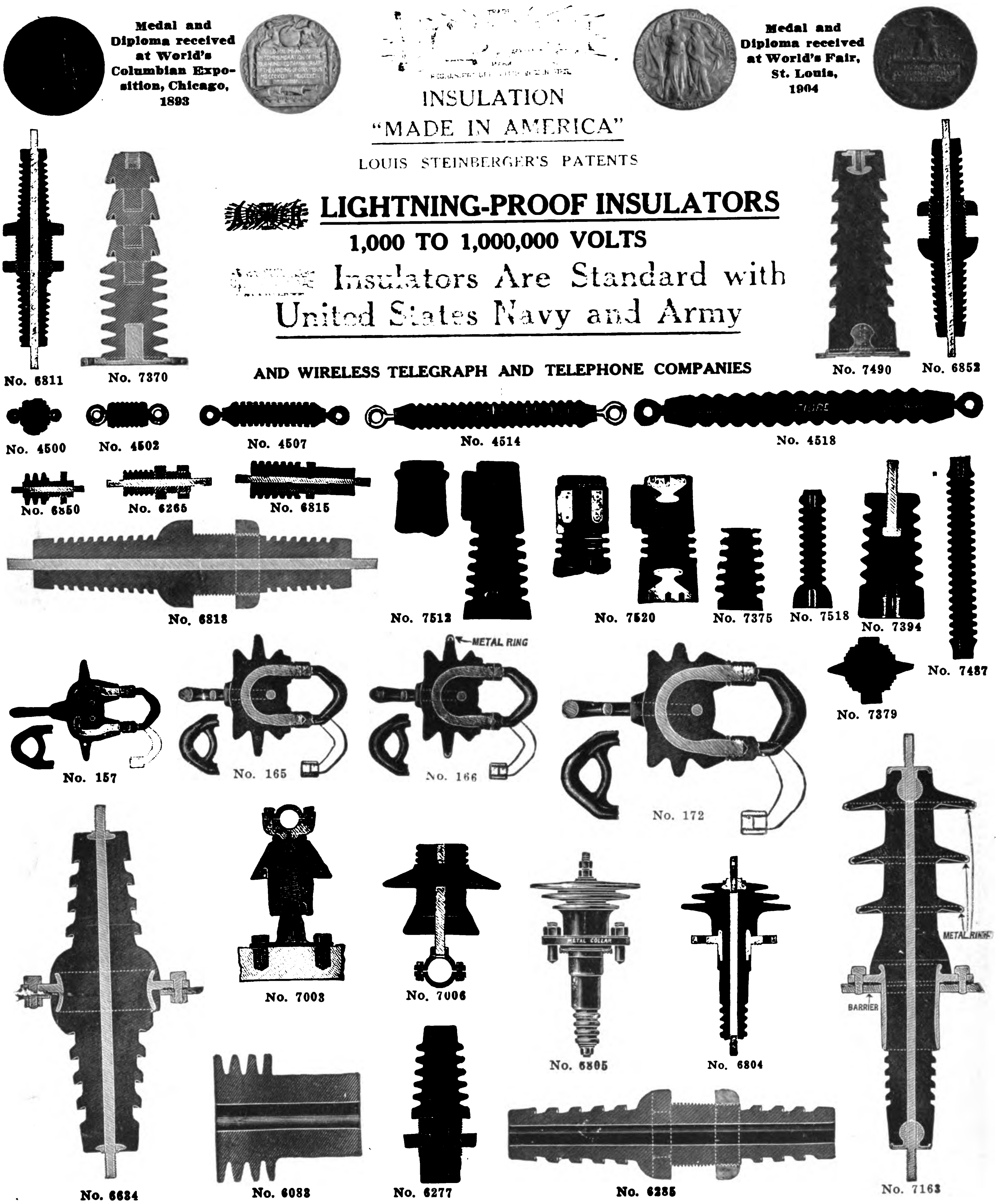

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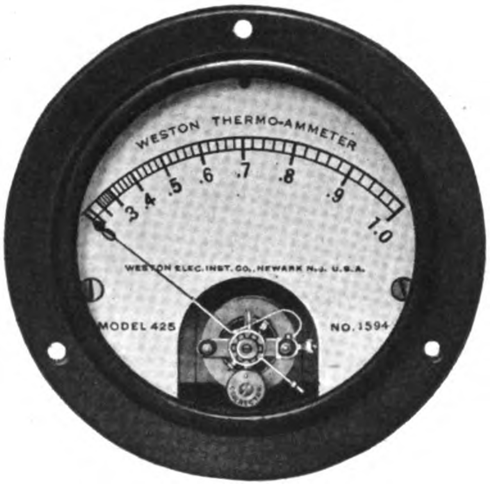

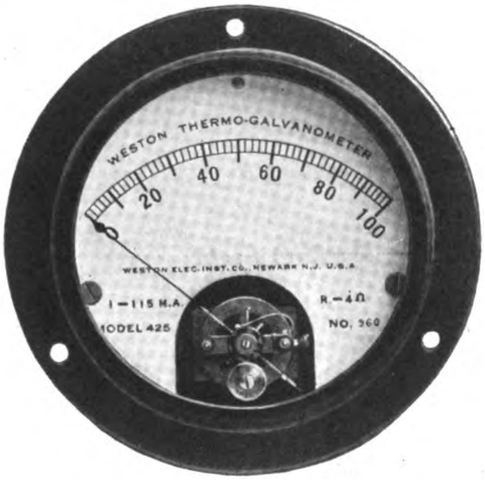
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The Wireless Age

Edited by J. ANDREW WHITE E. E. BUCHER, Technical Editor

Vol. 6 No. 10

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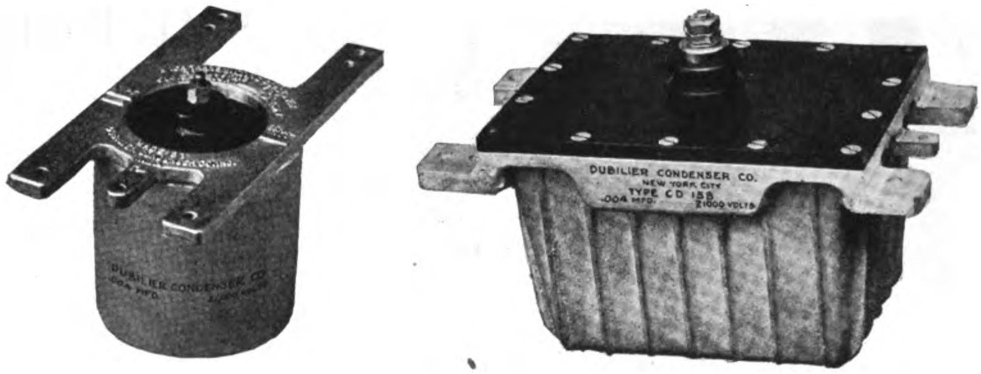

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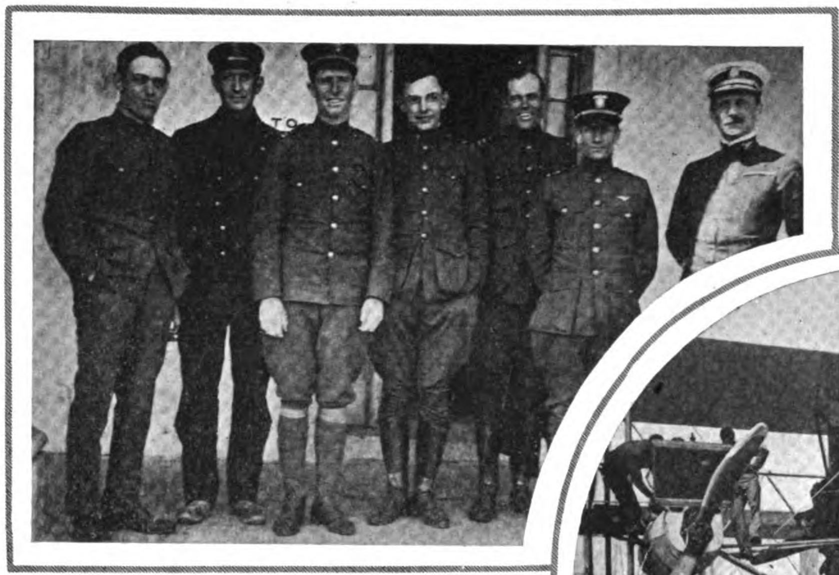
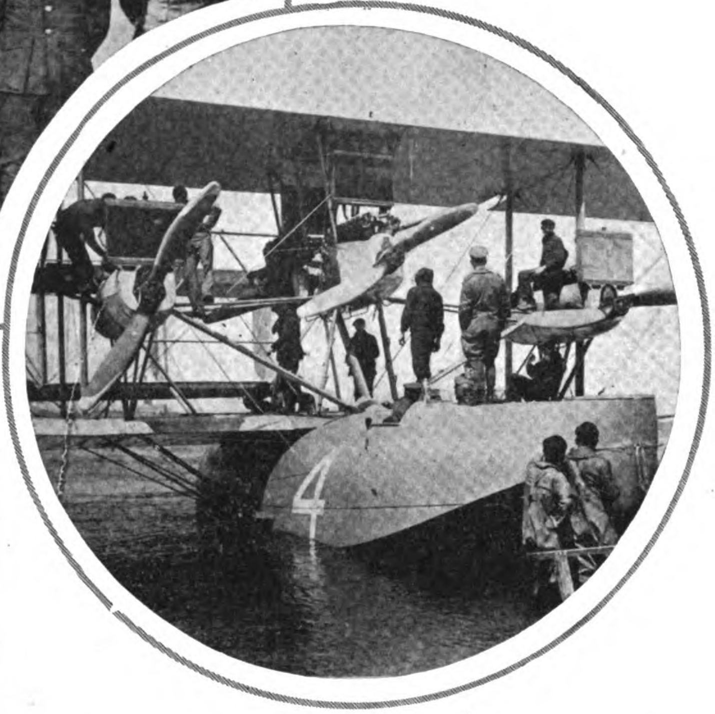
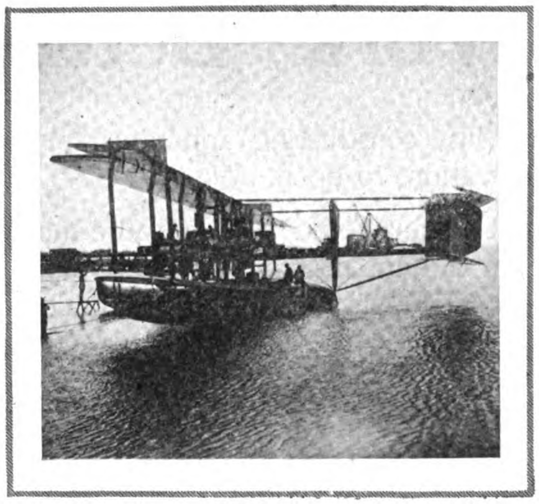
THE FLIGHT OF THE NC-4



Members of the pioneer cross-ocean air crew as they appeared when they landed at the Azores





Above, in the circle, a view of the final preparations and inspection prior to making the first overseas flight in history

On the left, the NC-4 just before leaving Rockaway Beach for the trans-Atlantic "hop"

Press Ill. Svce.

As Trepassey Bay looked as the three naval flying boats headed off across the ocean

Vol. 6. No. 10. July, 1919

THE WIRELESS AGE

WORLD WIDE WIRELESS

Wireless Telephony at Atlantic City

DEMONSTRATIONS of wireless telephony as applied to airplane movements, were among the features of the work of the second Pan-American Aeronautic Congress held recently at Atlantic City.

Many visitors and delegates had their first actual experience with this adjunct to aviation through the apparatus which was installed at the ocean ends of the Steel pier and Young's million dollar pier, and which established and maintained easy communication by the speaking voice with a seaplane in full flight about twenty miles off the New Jersey coast.

As used in the seaplane the apparatus clearly demonstrated the remarkable progress that has been made in constructing complicated instruments in a compact yet accessible manner. Formerly a radio telegraph outfit for sending and receiving occupied a large space, was bulky and cumbersome. Now one small table holds all the needed devices for either telephoning or telegraphing through the air.

National Radio School for Navy

GREAT LAKES has been chosen by the Bureau of Navigation as the site for the new radio school which is to be founded at this station. The first real information came through Lieutenant Mason, district communication superintendent and temporarily in charge of the radio school.

Plans beyond the tentative stage have placed the personnel in the new school at five thousand and there are possibilities of it assuming larger proportions. Commander Weaver in charge of all naval radio work in the United States will take command of this largest and only school of its kind in this country.

The school will be the center of all naval radio telegraph and radio telephone instruction work. Officers are firm in their belief that it will be one of the greatest educational institutions that the navy ever has afforded.

Tribute Paid to Wireless Heroes

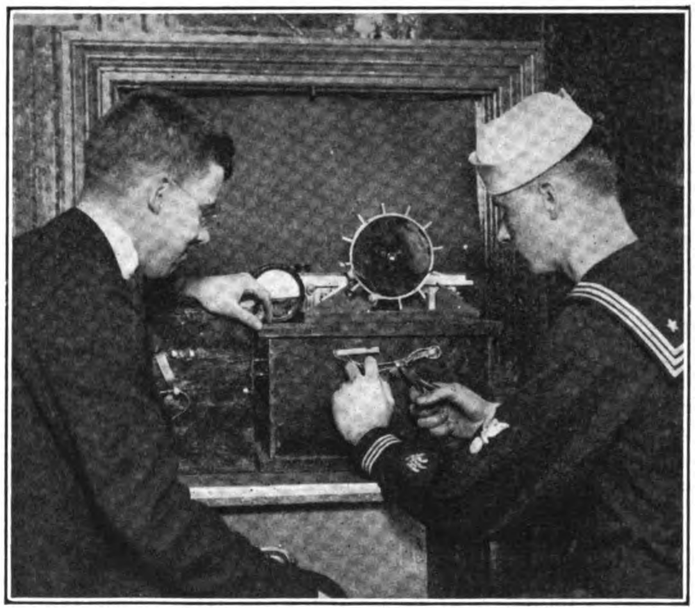
ON Memorial Day a wreath was placed on the monument erected in Battery Park, New York, in memory of wireless operators lost at sea. For the fourth successive year a committee of officials of the Marconi Wireless Telegraph Company of America visited the memorial fountain and with a simple ceremony paid tribute to the wireless men who have given their lives in the service of the merchant marine.

The monument was erected in 1915 by popular subscription during the time when the world was recovering from the shock of the Titanic tragedy.

Commercial Wireless Company for China

AN agreement has been signed between Marconi's Wireless Telegraph Company, Ltd., and the Chinese Government for the formation of the Chinese National Wireless Telegraph Company, with a capital of $3,500,000, half the amount to be subscribed by the Government and half by the Marconi company.

The Marconi company will manufacture wireless apparatus in China and also maintain existing and future wireless installations.



Press Ill. Svce.

A happy moment for the amateur for the naval man is breaking the seal of an amateur wireless apparatus silenced during the war

Wireless Aids Victim of Mysterious Shooting on Shipboard

IN answer to a wireless call from the steamship Makanda of the United States Shipping Board, lying off Sixty-fourth street, Brooklyn, Capt. John Smith of the police marine division responded in a police launch. He found John O'Donnell, 39, a fireman, suffering from a gunshot wound in the left arm.

O'Donnell said that when working on the deck he suddenly felt a stinging sensation and discovered that he had been wounded. He heard no gun report and said that the shot must have been fired from shore or from a passing vessel. He was treated and taken to Kings County Hospital.

Radio Service between Australia and Britain Under Consideration

A COMMERCIAL radio service between Australia and the British Isles is being considered by the Australian Government. It is estimated the cost of wireless transmission would be only one-third of cable messages. If the plan goes through, the cables still will carry the bulk of the code traffic.

The British War Cabinet has appointed a telegraphic communications commission, headed by Lord Milner, to consider the establishment of State-owned wireless stations throughout the Empire.

Wireless Telephone Discovered by Accident

THE wireless telephone was the accidental result of a search for something quite different—the wireless transmission of power. This was the opinion advanced at a recent meeting of the Institution of Radio Engineers in the Engineers' Building by E. F. W. Alexanderson, when accepting the gold medal of the institution in recognition of his original research and invention in the radio field.

"Radio telephony," he said, "is a by-product of the sustained radio waves as a method of alternating current power telegraphy to reproduce speech from the transmission. With the previous system of spark telegraphy it was no more possible to transmit the modulations of the human voice than it would be in land dots and dashes of the Morse code."

Marconi Company Wins Important Patent Litigation

IN a decree recently signed by Federal Judge Mayer, the Marconi Wireless Telegraph Company of America has again been successful in patent litigation under the Fleming Patent No. 803684 granted November 7, 1905 to Prof. John Ambrose Fleming of England, the famous Marconi wireless expert. This patent owned by the Marconi Company, covers the audion—known as one of the most sensitive instruments for use in wireless telegraphy and telephony—and the decree obtained by the Marconi Company is directed against the Atlantic Communication Company, which operated the high power wireless station at Sayville, Long Island, prior to the war in connection with German interests.

The Sayville station was built before the war and was finally taken over by the United States Government, so that no injunction could issue in this suit, but now the Federal Court has held that the receiving apparatus employing audions infringes the Marconi Company's Fleming patent and the decree excludes the Atlantic Communication Company from all rights in the invention.

The Court has appointed Judge E. Henry Lacombe, a special master to ascertain the amount of damages to be assessed against the defendant company, the assets of which are all in the hands of the Government.

International Company Begins Radio Phone Suit

A PATENT infringement suit has been started in the Federal District Court by the International Radio Company of Wilmington, Del., against the Western Electric Company of New York. The complaint alleges that the International Company owns six patents granted to Reginald A. Fessenden and that the apparatus covered by the patents is being used by the Western Electric in making radio-telephones which are being sold to the Government.

The plaintiff asks for triple damages if the defendant continues to manufacture and market the telephones.

The Armistice Preliminaries Hastened Through Use of Wireless

WHEN the Huns last fall somewhat feverishly indicated the desirability of cessation of hostilities it was the judicious use of wireless by Uncle Sam, in direct communication with the enemy on his own stamping-grounds which hastened the armistice preliminaries and brought the fighting to an end Nov. 11. It wasn't exactly according to Hoyle. In fact, communicating in such a forthwith and extemporaneous manner in that sort of situation "isn't done" in well-regulated diplomatic circles, or it hadn't been until your Uncle Samuel did it.

The story of how it was done was told in the New York Evening Post.

It was 12 o'clock noon—one day about Oct. 20, last—when every government wireless operator on duty in the allied countries was startled out of his wits by a signal-call from the radio-station at New Brunswick, N. J. The operators of the wireless stations of the central powers could not have been more surprised.

"P O Z—P O Z—P O Z—de N F F," buzzed the wireless. The allied radio operators saw immediately visions of brazen treachery or equally brazen German spy operations in the United States. They saw visions of an American war-scandal, such as the world had never known, court-martials and firing squads and possible revolution in America.

For P O Z is the radio call for the German government wireless station of Nauen, a suburb of Berlin, and N F F is the radio address of the United States naval sending station at New Brunswick, and the two had not been on speaking terms for a long time.

There must have been a real Prussian at the Nauen switchboard, for within two or three minutes, he responded patronizingly: "Your signals are fine, old man."

Whereupon the "old man" in New Brunswick proceeded to dispatch through ether a message which was not so fine as it was clear. No code was used. The message was in plain English. It was the first of President Wilson's statements to the German people carrying the suggestion that the allies would conduct no negotiations for an armistice and peace with the German government as then constituted.

Thereafter Washington was in constant communication with Berlin. Wireless was making history at a faster pace than all the engines of destruction on the battlefronts had ever been able to set up. Wireless was saving thousands of lives, perhaps millions. The negotiations between Washington and Berlin continued till the day the armistice was signed.

Japanese Ships Have New Wireless 'Phones

TOKIO papers state that wireless telephones are to be installed on the Toyo Kisen Kaisha passenger liners operating across the Pacific from San Francisco to Yokohama.

The department of communication of Japan, it is stated, is completing arrangements to connect the steamers at sea with public telephone centrals at Tokio and Yokohama by means of wireless telephone apparatus.

New York Manufacturer to Use Wireless

A PROMINENT electrical and radio manufacturing concern of New York City will install, as soon as the ban on sending is lifted, a complete Radio Telephone System between their factory and several branch stores, so as to relieve a greater portion of the land telephone traffic between these units of the organization.

Speed Record Made in Broadcasting Wireless Communication

THE navy in its effort to establish a world's record with a flight across the Atlantic, also set up a new mark in wireless communication.

With the seaplane NC-4 zipping up the North Atlantic coast to join its fellow fliers in cross-sea flight, Acting Secretary Roosevelt grew anxious as to Commander Read's progress. A wireless telegraph message to the NC-4 was transmitted as follows:

"What is your position? All keenly interested in your progress.

"ROOSEVELT."

Two minutes later the radio operator took the following reply by wireless telephone from Commander Read of the NC-4 on the desk at the Navy Department:

"Roosevelt, Washington. Thank you for good wishes. NC-4 is twenty miles southwest Seal Island, making eighty-five miles per hour.

"READ."

In three minutes the high power wireless stations had flashed the news to Paris, London, Panama, San Diego, Cal., and all ships at sea.

◆

Fort Cliff Wireless Compass Station Burns

THE Coast Guard and Radio Compass Station at Fort Cliff, Mass., has been destroyed by fire together with practically all of the life saving apparatus except a small surf boat. Members of the crew escaped by jumping from second story windows. The station was in charge of Capt. Matthew Hoar.

◆

Wireless Messages Received Inside Steel-Concrete Vault

A WIRELESS telephone message from the station at New Brunswick, N. J., has been received at Asbury Park inside a steel and concrete vault under-ground by W. Harold Warren of New Brunswick. He had a portable receiving set, carried in one hand, and neither aerial nor ground connection.

Two sets of head receivers were used; a wireless telephone speech from the New Brunswick radio station was heard distinctly.

The main dining room of the Hotel Klein, New Brunswick, was connected with the local radio station by regular telephone and a relay connection made by wireless telephone. The music of the hotel's orchestra was clearly heard by Mr. Warren inside the vault at Asbury Park.

The commandant of the naval station said that on the last trip of the steamer George Washington to France with President Wilson, the orchestra of the hotel was connected by wireless telephone with the vessel and the music was clearly heard when the ship was 600 miles at sea.

Canadian Forest Fires Fought by Wireless Telephone

CANADA is employing the wireless telephone and airplane in forest-protection service. Two machines have been installed in the Quebec district, and they operate in conjunction with patrol stations, with which the machines are in communication by wireless telephone. Such a system assures prompt discovery of forest fires and early effort at extinguishing the blaze may result in saving great quantities of valuable timber.

◆

New Transatlantic Station at Montreal

THE Marconi Company will erect a long distance wireless station at Montreal to handle some of its transatlantic business. The station will work directly with Paris according to the announcement.

A fine aerial for a hot summer day when signals are coming in bad

Audio Frequency Signals for Aviators' Use in Fog

THE Navy Department has adopted an audio frequency signal for aviators which will enable them to land with safety in a dense fog or in the dark.

This system of audio transmission which has been perfected has played a conspicuous part in the war and is now being applied to the uses of peace. It will be of advantage to navigators finding their way through fog into port, as well as to navigators in the air.

The difficulties encountered because of fog in the recent transatlantic flights of the NC-4's and the Vickers-Vimy airplane demonstrates the need of just such a device.

Mobile Station Gets Two New Towers

TWO new towers for the wireless station of the former Marconi station at Mobile, Ala., on top of the Battle House are being erected. This station is under the direction of the government at the present time. The towers were blown down in the storm of July 5, 1916, and were never restored except in a small way. The towers will be about 40 feet in height.

Nauen and Eiffel Tower Communication Resumed

WIRELESS communication between Nauen and the Eiffel Tower in Paris has been resumed so that the German peace delegation can keep in close touch with Berlin.

British wireless men of the 11th Corps stationed at Weisdorf, Cologne. The building in the background is a part of the great German chemical works at Weisdorf

Two Laymen's Views on Radio

If wireless is going to be the means of communication in the future, why have any argument over the German cables?—*Buffalo Commercial.*

Now that the wireless telephone between America and Europe has been established successfully, one would love to hear what Richard Strauss is saying at being ousted from his conductorship and directorship of the Berlin (no longer Royal) Opera.—*Philadelphia Record.*

Wireless Outfit on Roof of Flying Club in New York

THE American Flying Club, 11 East Thirty-eighth street, New York, has now a radio outfit with which the members hope to keep in touch with aircraft flights at a great distance.

Advantages pointed out at the clubhouse are that the club will be able to promote public interest in the operations of aircraft by disseminating such information as may be received. The members, most of whom served as pilots in the European war, feel generally that it will be a help to their craft in many ways if they can educate the public regarding it. They believe that at present too little is known about the doings of the fliers.

Recently, it was stated at the clubhouse, many flying clubs of other cities have written to this organization suggesting affiliation.

The club's president is Lawrence L. Driggs and its honorary president Gen. Charles T. Menoher, head of the army air service. Many noted air fighters are among the members. It has no connection with any other organization.

Americans Ably Assist a German Station in Africa

AS late as the middle of January a German wireless station was operating in Africa. How this station was discovered and the amusing incident which accompanied the discovery is reported by Gordon Stiles, Chicago News correspondent. It appears that the officers of one of the giant radio plants conducted by the American army of occupation had their suspicions aroused by the nature of the messages which were being sent out from the Nauen tower near Berlin, and after a long investigation they came to the conclusion that the German government was communicating with some foreign station.

Working on that theory, they finally discovered that in the mass of news and propaganda emanating from Nauen was a code. Further, it developed that these code messages were addressed to a station in Africa. Once the Americans had worked out the code it was easy to decipher the messages, which really were harmless, but the German government had been steeped in intrigue for so long that it was second nature to go the longest way around if there was an element of secrecy in such a course.

At any rate, having the messages in their possession, the American wireless men sat down to await the reply. This came in due course and was easily received by the American operators. Not so with the Nauen tower. It seems that the waves were very weak and also that the German amplifiers have been surpassed by those of the American radio service. The result was that the Germans never received the message.

The officer in charge of the American station is a bit of a wag. He held up the message three days and then sent it through in perfectly good German to the Nauen tower, adding, "So sorry, old man, your amplifiers are not up to the Yankee ones," and the Nauen tower operator was a good enough sport to acknowledge the message. Nothing has been heard of the African station since.

New England's Compass Stations Installed

ONE of the most helpful uses of wireless has been inaugurated in the radio compass stations now being installed at harbor entrances and at dangerous headlands around the New England coast. On the Rhode Island shore, there is one at Prices Neck and another is under construction at Watch Hill. The arrangement enables a vessel, by wireless communication with the stations to get its compass bearings with respect to the coast, or find out its position at sea. The stations will furnish positions to ships within thirty miles of the entrance to the outer channel of a harbor, and bearings to within one hundred miles.

Within the radius of the operation of these stations there should be no repetition of such miscalculation as resulted in the stranding of one of our transports from Europe on Fire Island, while feeling its way in a fog toward New York. There are various methods of finding the position of a ship on approaching land, but only one, taking soundings, is available in weather thick enough to shut out the shore line; and the lead is of little use until the ship is in dangerous proximity to the land. In the case of the stranded transport the navigating officer had been tracing his course by dead reckoning, after some days of fog. Had he been able to call a compass station he could have obtained his position and true bearings as soon as he approached the New England coast, and been guided safely to New York by repeated communications. For ships on the sea not looking for a harbor entrance, the service should prove equally valuable where the latitude and longtitude have become uncertain owing to encounters with storm or fog.

Weagant's Anti-Static Invention

Details of a Great Discovery That Has Revolutionized Long Distance Wireless Communication*

An abstract of a paper read before a joint meeting of the New York Electrical Society and the Institute of Radio Engineers at a monthly meeting, Wednesday, March 5th, 1919.

Part II

Reported by Elmer E. Bucher

Director of Instruction, Marconi Institute

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IT was mentioned in the preceding article that Mr. Weagant observed the necessity for local tuning of each loop in all arrangements employing two widely separated closed circuit loops or cages connected to a central receiving station by long low horizontal leads. This required placing an operator at each cage and informing him by telephone just what adjustments were to be made in order to change the wave length or to obtain a good static balance. Obviously, this was not a convenient arrangement, and an added objection previously mentioned, was that the long, low horizontal leads acted as aerials, picking up both static and signals. Although this particular structure gave a marked reduction in static currents while retaining useful amounts of the signal currents, it cannot be said to have fully satisfied the requirements of modern radio engineering and commercial practice.

In an effort to overcome the troubles incident to the use of the loops with long low leads, Mr. Weagant and Mr. Waterman, jointly, conceived the idea of making the loop and lead-in wires, one; and accordingly experiments were conducted with two loops, each of which consisted of a single turn of wire extending out from the station and back again. This arrangement was free from points where abrupt changes in the circuit constants took place, which was not the case with the cage aerials which made use of the long horizontal leads.

A particular form of the Weagant-Waterman antennae is shown diagrammatically in figure 18. In figures 19 to 33 other structures are illustrated, showing experimental steps with various loops consisting of a plurality of turns, or single turns with different spacings and other modifications. In the practical installation of the system of figure 18 at Lakewood, N. J., in the spring of 1918, the spacing between the upper and lower wires was 15 feet. The poles were 30 feet high and each loop was about three miles in length.

One of the first discoveries made in connection with the enlarged single-turn loops, was that they could not be tuned to sharp resonance with any particular incoming frequency; in fact, the insertion of inductances and capacities in the loops to establish resonance at different wave lengths had seemingly no effect upon their frequency of oscillation.

It was believed that this result was due to a current distribution in the loops of such a nature that a current node existed at the point of insertion of the tuning devices. This distribution was successfully altered by the insertion of inductances at suitable points. A coil of 30 millihenries was inserted, successively, in the upper wire at points between the receiving station and the other end of the loop; it was found that the tuning improved constantly as the coil was moved from one end toward the middle, but it became poorer as the coil was moved from the middle toward the end.

It is interesting also to note that when an inductance was inserted in the lower wire it produced no result. When coils were inserted in the middle points of both lower and upper wire at the same time, the effect of the latter was annulled. Experiments showed that 30 millihenries was about right for a wave length of 12,000 meters and 5 millihenries for 6,000 meters, but either value was sufficiently acceptable for both wave lengths, with loops each three miles long.

After this definite method of tuning had been determined, the results secured in balancing out static and retaining the signal were most satisfactory. The over-all results obtained were better than those secured with smaller loops spaced far apart and connected to the receiving apparatus with long low horizontal lead wires, because in that arrangement the leads had acted as aerials and reduced the effective spacing of the two end loops or cages. The most effective spacing of two such loops was found to be one-half wave length between the centers, which is in agreement with the theory previously outlined.

Special Forms of the Weagant Antennae

An exhaustive series of experiments with enlarged loops of various types were carried on at Lakewood, N. J. Various modifications such as shown in figures 19 to 33 were put under observation. In most of these drawings, the antenna structures are self-explanatory. All those used were found effective in eliminating static interference.

It was believed that the construction shown in figure 31 would give greater effective wave length separation if the receiving aerial extracted energy from passing electromagnetic waves in accordance with the usually accepted theory. But the experiment proved quite conclusively that the loops did not behave in accordance with this assumption and, as Mr. Weagant stated, his whole work has demonstrated that existing ideas of the mechanism by which the loop aerial extracts energy from a passing electromagnetic wave will have to be considerably modified.

In explanation of the special constructions shown in figures 19 to 33: In figure 19 the two ends of the loop are left open at point 3. This arrangement was found to operate quite as effectively as when the circuit was closed. In figure 30, the loops are closed at the ends 4 by variable condensers. In figure 21, the loops are open at the upper conductors 6. Figures 22 and 23 show loops with different spacings between wires, figure 23 particularly showing the loops supported a greater distance above the earth than in the preceding figures. Figures 24 to 29 show loops containing a plurality of turns, while in figures 30 to 33 forms of loops having graded constants are indicated. In the circuit shown in figure 24, the localized inductance 15 is included in the construction of the loop itself; it may be located at any desired point in the length. In all these arrangements the lead-in wires extending from the end of the loops nearest the receiving

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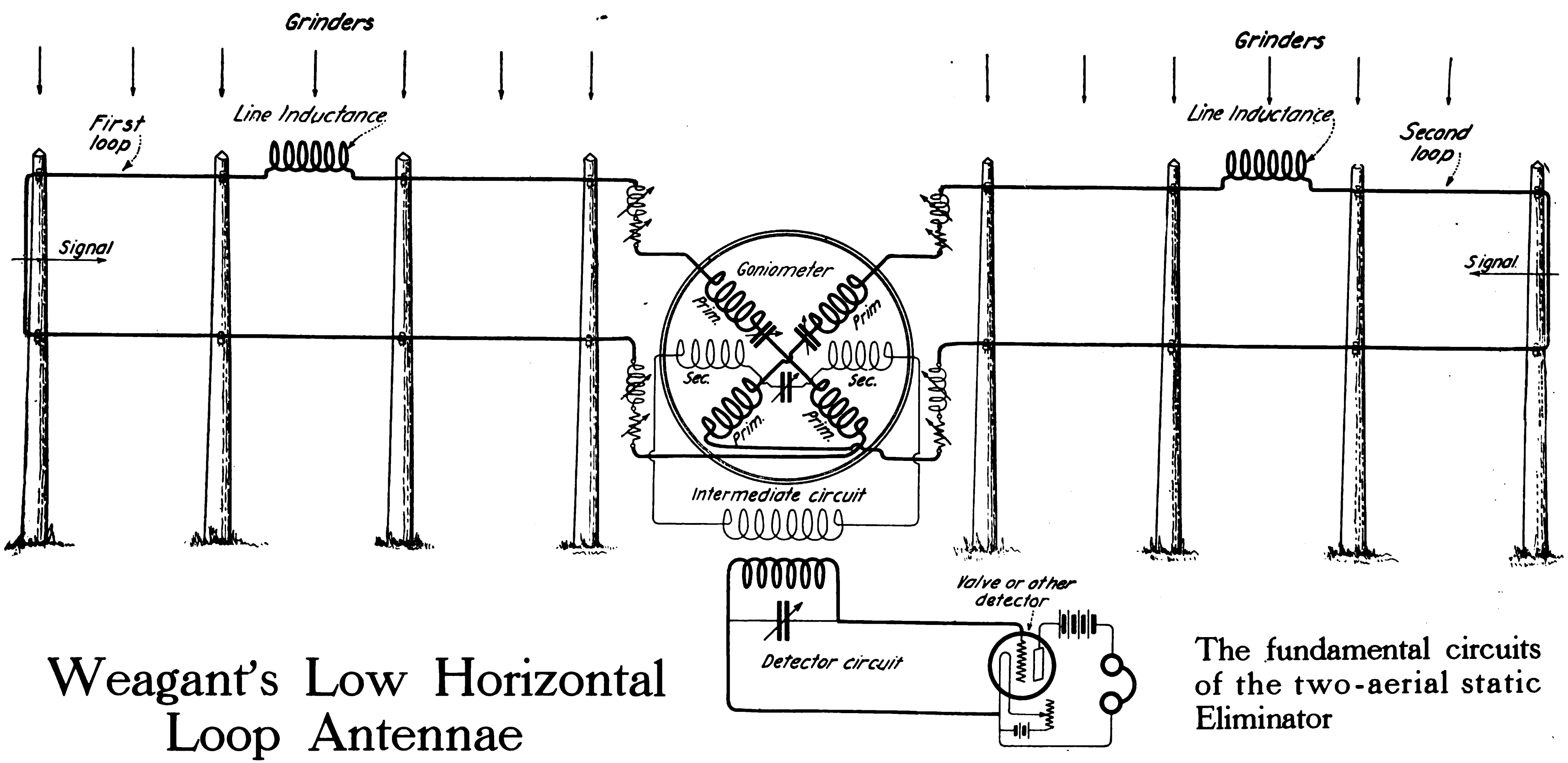
* Several of the drawings included in this abstract were not disclosed at the Institute meeting. Special permission to publish them in the Wireless Age has been granted by Mr. Weagant.

Weagant's Low Horizontal Loop Antennae



The fundamental circuits of the two-aerial static Eliminator

Figure 18

This diagram shows the fundamental circuits of the two-aerial Weagant system permitting continuous reception of long distance wireless telegraph signals through "static" interference which ordinarily would render the wireless signals unintelligible.

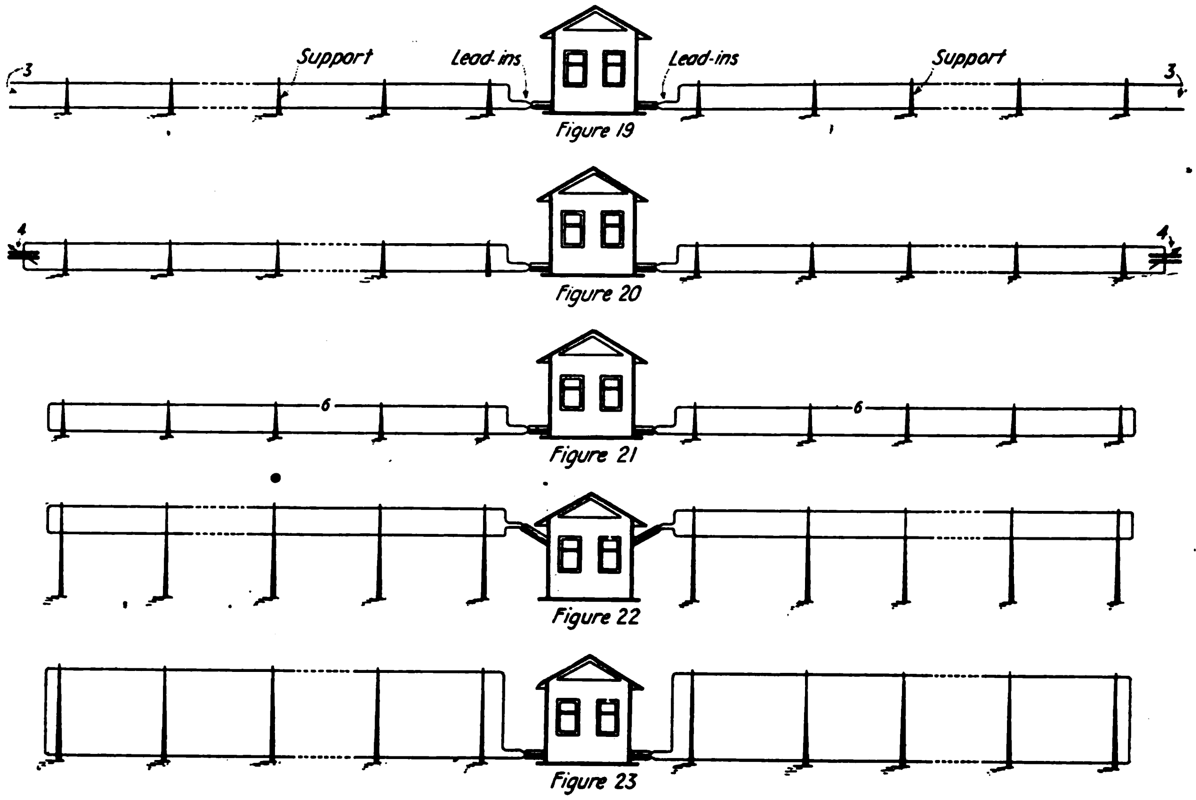
Mr. Weagant, having discovered that the dominant type of static termed "grinders," is apparently propagated vertically in respect to the earth, made use of the two loop antennae as here shown, to balance out static currents, while retaining the signal currents. In practice, the antennae are spaced any distance from center to center, the most efficient separation being one-half wave length. The terminals of both loops are connected to the two primary coils of a radio goniometer. The secondary coil of the goniometer is connected to a detector circuit which, in this diagram, includes a three-electrode vacuum tube. Appropriate loading inductances and variable resistances are connected in series with the leads of each loop to obtain the desired operating characteristic. A line inductance is inserted at the center point in series with the upper wire of each loop. Since the vertically propagated static waves act upon both loops simultaneously, the resulting E.M.F.'s are in phase and may be made to neutralize in the goniometer. Wireless signals on the other hand advancing either from the right or from the left, strike the two aerials at different times and the resulting currents are out of phase and their E.M.F.'s combine vectorially; that is, at any particular instant, the static currents and the signal currents in one loop flow in the same direction and in the other loop in opposite directions. Since the goniometer coils are coupled to the detector circuit in such a way that the static currents oppose and neutralize, the signal currents add their E.M.F.'s according to the effective separation of the loops. Experiments have been made with loops of various lengths up to three miles each, that is, with a complete antenna system six miles in length. In every case, it was possible to balance out the static currents and retain a useful amount of the signaling currents, thus proving Weagant's theory that static waves act perpendicularly in respect to the earth. This discovery represents the greatest progress in the art of radio communication since Marconi's original disclosures.

Not only does the Weagant system permit continuous reception through the severest types of static interference, but it has done away with the necessity for high towers, allows great distances to be covered with less power at the transmitting station and for the first time makes possible the use of an automatic recorder.

station are passed into the receiving apparatus through metallic covered cable.

Practical Circuits

Detailed working circuits of the Weagant two aerial system for static elimination may now prove of interest. Figure 34 shows more fully the station house circuits disclosed fundamentally in figure 18, with the exception that the centrally located line inductances are not shown. Loading coils L-6 and L-7 are inserted in the lower lead of each loop and reversing switches S-1 and S-2 are placed between the loops and stationary goniometer coils, to obtain the most effective working. Variable condensers C-1, C-2 and C-3 are inserted in the center of each goniometer coil. Another reversing switch S-3 is placed in the intermediate tuning circuit which includes the rotating coil of the goniometer L-3, the load inductance L-4 and the coupling coil L-5 acting upon L-6 which in turn actuates the oscillation detector V-3.



Figures 19 to 23—Various forms of the Weagant antennae system utilizing two single turn loops separated at an appreciable fraction of a wave length

This particular diagram shows an oscillating vacuum tube, the plate circuit being shunted by an inductance and capacity in series, but any type of detector and circuit suitable for damped or undamped wave reception may be employed.

Because the variable condensers are connected in series with the stationary goniometer coils, the circuit of figure 34 is said to employ *series* tuning in contrast to figure 35 where the same condensers are connected in *parallel* with the stationary coils. The diagram, figure 36, on the other hand, includes a set of switches which permit either *series or parallel* tuning, at the will of the operator.

In the improved circuit, figure 35, line inductances L-9 and L-10 are inserted at approximately the center of the upper wire of each loop, the lower wire of each loop containing the loading coils L-6 and L-7. In the universal circuit for the two aerial arrangement shown in figure 36, S-1 and S-2 are reversing switches inserted between the leads and the goniometer; S-3 and S-4 permit the variable condensers C-1 and C-2 to be placed in series or in parallel with the stationary goniometer coils. For series tuning, the single blade switches S-5 and S-6 are opened, S-3 and S-4 being closed to the top set of contacts. For parallel tuning, S-5 and S-6 are closed, S-3 and S-4 being closed to the bottom set of contacts.

Loading inductances L-11, L-12, L-13 and L-14 are placed between the leads and the goniometer coils so that either one or two loadings may be cut in each loop. The reversing switch S-7 permits the most favorable connection to the detector circuits to establish a satisfactory static balance.

In all of the foregoing arrangements, the general procedure to balance out static and retain the signal is, in brief, as follows: The rotary coil of the goniometer is placed in inductive relation to one of the two loops; the circuits are then tuned until the maximum signal strength is obtained. A similar procedure is carried out in respect to the other loop. Both loops are then connected to the goniometer and the third coil is rotated to a position giving maximum signals and minimum static. A finer balance is then obtained by adjusting the inductance, capacity and resistance in both loops.

One particular modification of the Weagant system for the elimination of static is shown in figure 36-A, a circuit which was employed in very early experiments at Belmar, N. J. Fundamentally, it consists of a loop antenna A-1, grounded to earth through the tuning inductance L-1 and the variable condenser C-1. The coil L-1 acts inductively on the secondary coil L-3, the terminals of which are extended to a detecting circuit as usual. A closed circuit loop A-2 of the early type, with long low horizontal leads was connected to the coil L-2 with the variable condenser C-3 in series; this coil also acts inductively on the secondary L-3.

It was possible with this arrangement to take advantage of the relative flow of currents and the inherent differences of phase between the currents in the grounded antenna and in the closed circuit loop, to balance out static currents and retain the signal currents.

Commenting upon the results obtained with the two aerial system as installed at the Lakewood, N. J., station, Mr. Weagant said:

"This station was operated continuously from the middle of July until the end of September with a force of three operators, each working eight hours, copying messages sent out by Lyons, Carnarvon, and Nauen, regularly, and occasionally other stations. This continued operation was undertaken to determine the capabilities of the system in a practical, commercial way, during the worst period of the summer and at all hours of the day. The results secured were most gratifying, the total interruptions experienced being of no greater total duration than those of good cable working between the same points and at the same time of year.

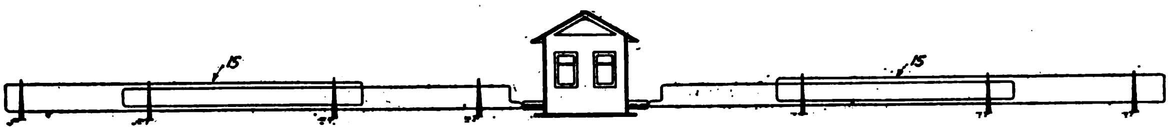


Figure 24

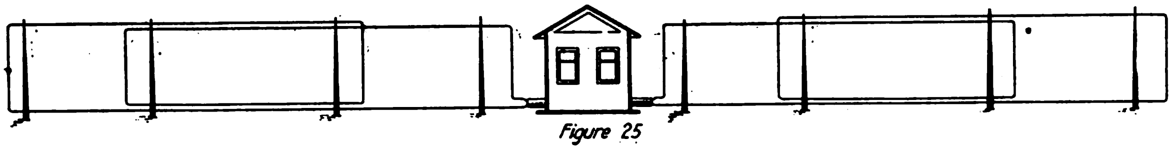


Figure 25

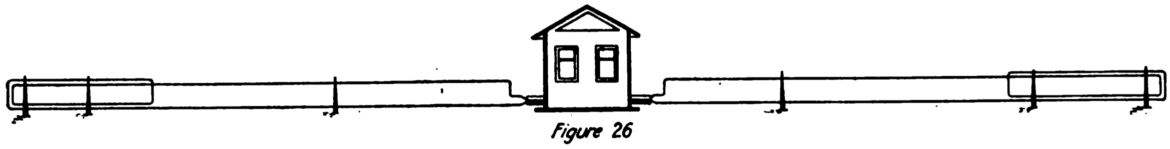


Figure 26

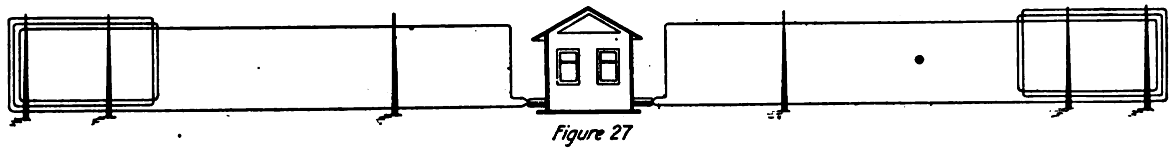


Figure 27

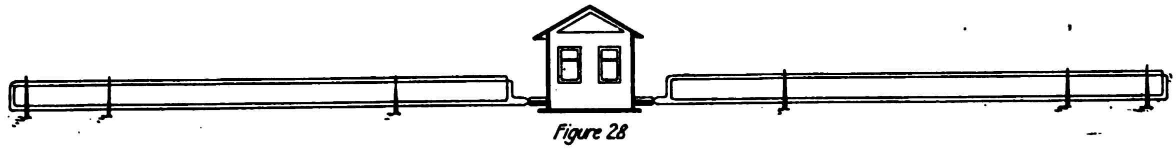


Figure 28

Figures 24 to 28—Loop aerials of the Weagant system containing either a plurality of turns throughout their length or through a part of their length. Various spacings between the upper and lower wires and between the wires and the earth are indicated

"It was found that when the signal from the European stations was of normal intensity the heaviest static experienced at any time was unable to interfere in the slightest, but that on the contrary, it might have been very much more severe without causing trouble. Reception under this condition was almost invariably good enough for high speed automatic reception.

"A few thunderstorms occurred during this time and some, but not all of them, prevented reception while they lasted. There were also periods recurring regularly every day between four and six o'clock in the afternoon and between twelve and two o'clock in the morning when the intensity of the received signals from Carnarvon and Nauen fell off enormously, on some occasions falling as low as 1/100th of their normal intensity. During a few of these fading periods, interruptions were experienced varying from five to ten minutes, to perhaps one hour. The worst of these periods was usually—but not always—the midnight to two a.m. period when, although the static was generally lighter than during the afternoon fading period, at which time its maximum intensity occurred, the decrease of signal strength was rather greater. A careful study of the conditions during these fading periods, convinced me that the difficulty was due to the fact that when the signal weakened greatly the click type of static was present in sufficient quantities to cause the trouble, and that when the signal intensity was greatly amplified in order to be heard, the amplification also brought up this disturbance with its ratio to the signal unaltered."

Continued experimenting eventually culminated in the perfection of a three aerial system which eliminated most effectively both the grinders and the click type of static and moreover gave signals of sufficient audibility for continuous reception from European stations of a much lower power than required to give response with the two aerial arrangement. The three aerial arrangement permitted reception through the worst fading periods without interruption.

CHARACTERISTICS OF STATIC

In support of his theory which classified "grinders" as a type of static which is propagated vertically, and the "clicks", a type which is propagated horizontally, Mr. Weagant declared that continuous experimenting had established beyond doubt that the characteristics of the two prevailing types of static were well defined. The "grinders" are most prevalent in the warm season, between the noon hours and sunrise of the following morning.

Grinders generally produce in the telephone a continuous rattle, with occasional heavier crashes. This type of static seems to be vertically propagated and certainly affects aerials separated by considerable distances simultaneously. The two aerial system effectually excludes the grinders. The click type, however, which is apparently propagated horizontally, had to be dealt with in another manner.

Defining the clicks, Mr. Weagant said they are widely spaced crashes and are most noticeable during the cooler periods of the year and day. They do not interfere, except on rare occasions, with signals equal to the normal strength of Carnarvon, Nauen, or Lyons, but during reception from stations of smaller power, such as Clifden, Ireland and Eiffel Tower, Paris, the clicks caused marked interference with the two aerial arrangement, and any adjustments that reduced the click type of static reduced the signal also.

By applying a principle hitherto unknown in radio engineering, both clicks and grinders were eliminated while the full signal strength of foreign stations was retained. A description of the three aerial arrangement follows.

THE STATIC TANK

Since the two loop aerial system had not as yet shown itself capable of sufficiently differentiating between the horizontally moving type of static and the signal so as to permit reception during the severest periods of signal fading, Mr. Weagant carried on a series of scientific investigations with a three aerial arrangement in which the two loops of the previous system were used as a "static tank." This system made possible the reception of signals from European stations of a much lower order of power than that employed by Carnarvon or Nauen. Although many times during the summer attempts were made to copy Eiffel Tower, France, on 8000 meters, with the two aerial arrangement, satisfactory signals were obtained only during the time when the "grinders" type of static predominated. When the "click" type of static occurred these stations could not be read. As a proof of the utility of the three aerial system a particular test was made through static disturbances of such intensity that the signals from Eiffel Tower were much below normal. It was barely possible to determine the presence of signal with the two aerial arrangement, but with the three aerial arrangement the signal was not only readable, but was of such intensity that it could be read with the telephones removed from the ear.

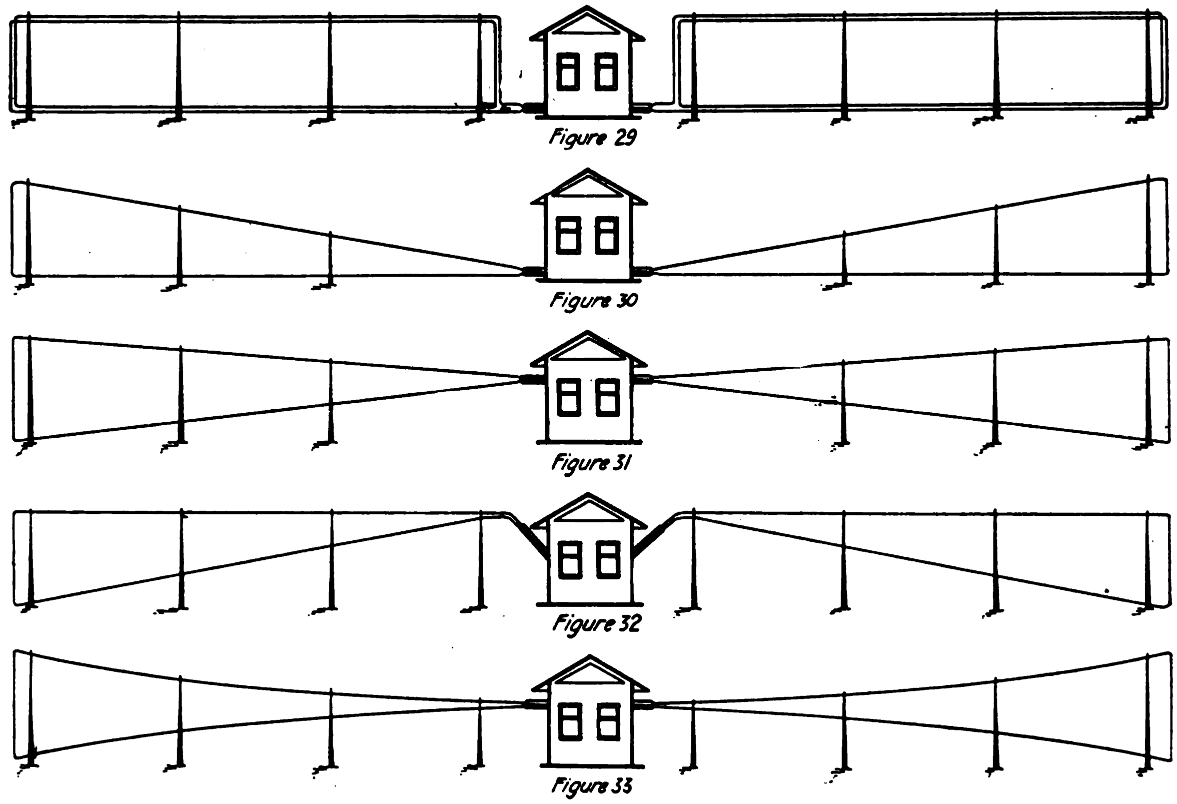


Figure 29

Figure 30

Figure 31

Figure 32

Figure 33

Figures 29 to 33—Experimental forms of the Weagant loop antennae designed to have graded constants

Before going into the details of the static tank, it may be well to define it briefly. *The static tank may be characterized as a source of static currents of both the click and grinders type of variable frequency, but not a source of wireless telegraph signals.* Hence, static currents can be withdrawn from the static tank to balance out the static currents in a third receiving aerial associated with the system (which picks up both static and signals) retaining only the signal currents. As will appear further on, several modifications of the static tank are possible, but the one about to be described has proved very effective, and from a commercial viewpoint is thoroughly practical for 24 hour transoceanic reception.

Referring now to the diagram, figure 37, it will be observed that two closed circuit loop antennae, each of which are 3 miles long (for the longer wave lengths) are mounted on short poles and connected to the primary coils of a goniometer located at a central point of the antenna system. As usual, the detecting circuit is coupled to an intermediate circuit which embraces the rotating coil of the goniometer.

Immediately underneath the closed circuit loops is a long low horizontal antenna A-1, 6000 feet long (in the Lakewood installation) which, through the medium of the coils L-15 and L-16, is coupled to the intermediate tuning circuit, which circuit also includes the rotating coil of the goniometer. All three antennae lie in the same plane and are preferably pointed in the direction of the sending station.

In contrast to the two aerial system, of figure 18 and others following, the two loops in this arrangement are used to build up the static currents and to balance out the signal currents. The two loops then constitute a static tank in which static currents of any desired frequency may be stored up, so to speak, for balancing purposes.

The long low horizontal antenna A-1 on the other hand, picks up both static and signals and its primary coils L-15 and L-16 also act upon the detector circuits. By effecting proper coupling and connections between the static tank and the receiving aerials, the static currents accumulating in the static tank can be brought into opposite phase with the static currents in the horizontal antenna, resulting in substantially complete annulment, yet retaining the full strength of signal. In fact, Mr.

Weagant pointed out that the strength of the resulting signal was equal to that obtained with the two aerial arrangement when it was adjusted to give maximum signal currents rather than maximum static currents.

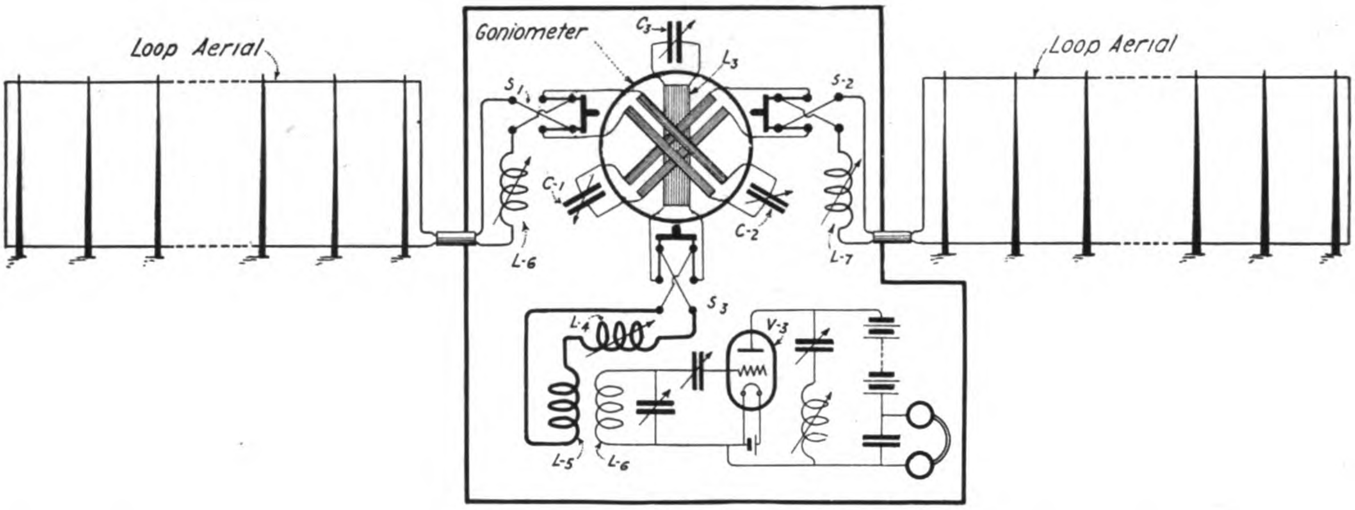


Figure 34—Circuits of the Weagant two-aerial system for static elimination showing the position of the goniometer and the necessary reversing switches for obtaining a satisfactory static balance. In this circuit the variable condensers are connected in series with the goniometer coils

How "Clicks" and "Grinders" Accumulate in the Static Tank

The fact that the static tank becomes a source of static currents of both the *click* and *grinders* type requires some explanation. For it would appear that since the "clicks," which have been classified as a type of static that is propagated horizontally, would be neutralized as are the signal currents when the goniometer is adjusted to annul signals. The static tank, however, has proved to be a source of both "clicks" and "grinders" as will now be explained.

Assume the reception of highly damped static waves from left to right or vice versa upon two loop aerials such as shown in figure 37, giving one-half wave length separation for the signal wave; the static wave acts first upon one aerial and then on the other, with the result that the first half-cycle of the highly damped oscillation in the first aerial is unopposed, because the current has had time to go through a complete half-cycle, before the wave continues its motion and affects the second loop.

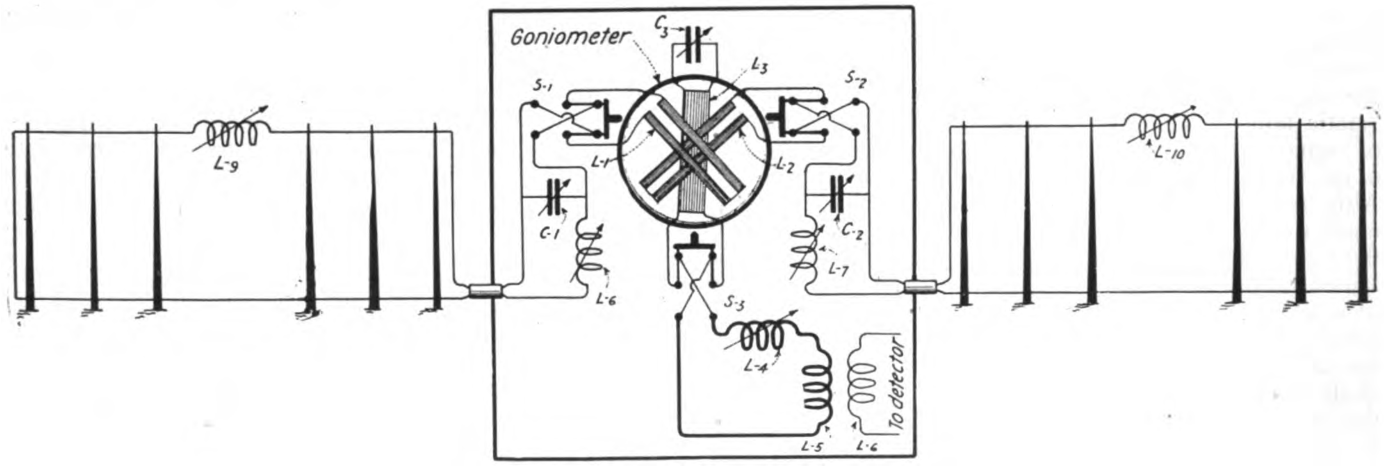


Figure 35—A modification of figure 34 employing parallel tuning. The condensers C-1 and C-2 are connected in parallel with the leads from the loops

The current generated in the second loop then flows back to the receiving apparatus. Further consideration will reveal that the first half-oscillation from the second aerial is opposed to the second half-oscillation from the first aerial, and so on throughout the wave train. But because the oscillations are damped, the opposing cycles in the first and second loops do not have the same amplitude and accordingly the result of the opposing oscillations is not zero as shown in figure 38. In other words, useful amounts of the click type of static as well as the grinders type are retained by the static tank and may be used to balancing out similar static currents in an ordinary receiving aerial. Still better results are secured by damping heavily the loop antennae through the insertion of series resistances until the wave trains, due to static, become shorter and shorter until all the energy is dissipated in the first half-cycle. Under these conditions, although the loops are coupled to the receiving set so that the wireless signal completely cancels out, the entire static current remains, resulting in the curious curve shown in figure 39 which comprises two half-oscillations, both in the same direction.

Mr. Weagant was careful to point out that the first half-oscillation of the signaling current is also unopposed, but in the case of undamped wave reception only 1/7000 part of the energy which is required to make a dot effects the detector; in other words, the static tank retains a very slight amount of the signaling current even when the loops give one-half wave lengh separation. A general order of the result obtained with the most effective spacing may be secured with any appreciable wave length separation; that is, although the loops may have fixed dimensions, they can be worked over a considerable range of wave lengths with slight decreases in the intensity of the signals.

In regard to the reception of the clicks propagated at an angle to the planes of the loops, it is interesting to note that as the angle increases, the resulting static pulses overlap, as shown in figure 39-A; and, as Mr. Weagant pointed out, through part of the azimuthal angle, the intensity of the oscillations produced by static vary along the cosine curve, spreading out somewhat as the angle increases. If, therefore, this system is balanced against a third aerial, the curve of reception of which is a cosine curve and both signal and static currents are flowing, the static currents due to the click type of static will oppose and the residue will be the order of the difference between the dotted curve shown in figure 40 and the cosine curve shown in the solid lines. From this it is apparent that a very large order of reduction is possible, retaining the full signal strength developed by the third aerial.

Early Form of the Static Tank

One of the early methods of using the static tank is shown in figure 41, wherein the cages or loops A and B are separated several thousand feet and connected to a centrally located receiving set by long low horizontal leads. The loop E, which in this case is the receiving antenna, is also coupled to the receiving set. Like the method shown in figure 37, loops A and B are employed as a static tank and loop E is the receiving aerial which picks up both static and signal waves. The procedure in this case is as usual in the three aerial system; the loops A, B and E, are all tuned to the frequency of the incoming signal, but A-1 and A-2 are coupled to the common receiving circuit in such a way that the signal balances out, the static currents being retained. The loop E picks up both static and signals and is also coupled to the receiving circuit. By proper adjustment of couplings, etc., a complete static balance is obtained.

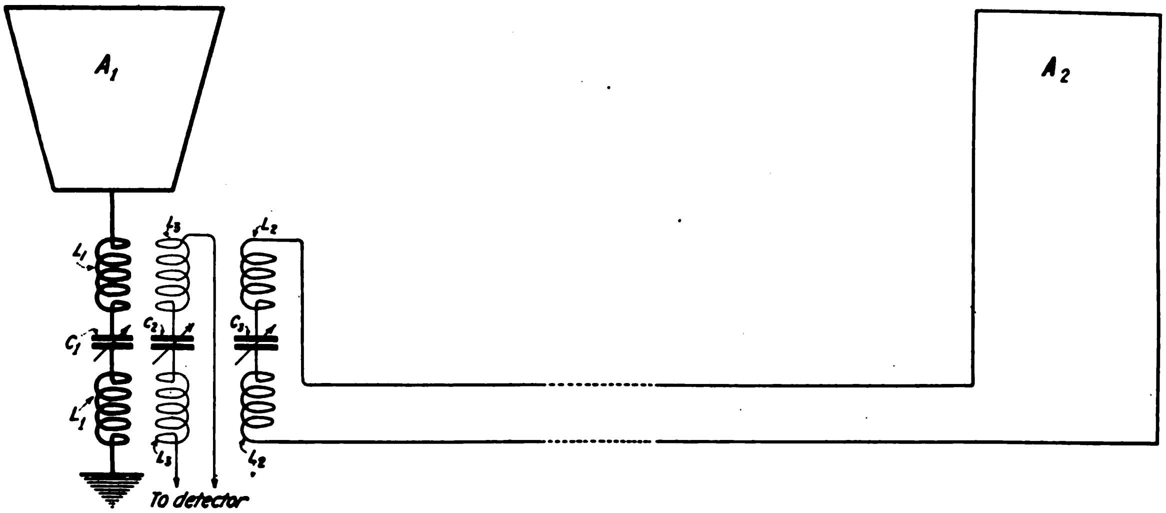


Figure 36-A—Showing the antenna structures employed by Weagant in the early experiments at Belmar. A loop connected up as a straight-away aerial was grounded to earth and balanced against a loop, with long low horizontal leads

The "Whippet" Static Tank

In order that the static tank aerials may give one-half wave length separation, very long antennae, up to six miles in length, are required for the longer waves employed in wireless communication from continent to continent. Offsetting any objection which might arise on this score, Mr. Weagant astonished his listeners by describing a miniature form of static tank and associated receiving aerial capable of transoceanic reception, which could be mounted upon the speaker's platform. He described the arrangement illustrated in figure 42, which, in addition to acting as a static tank, serves to prove that electromagnetic waves while in transit may be considerably distorted from their initial angle in respect to earth.

In brief, a horizontal antenna A-1, 25 feet in length is mounted on a "tether" arm B, which may be rotated around its vertical axis on the pivot P and placed at any angle in respect to the earth. The horizontal antenna mounted on the "tether" is associated electrically with the closed circuit loop A-2 which is employed as a receiving antenna. The "tether" antenna is employed as a static tank; that is, it may be made a source of static currents, but not a source of signal currents. The loop, on the other hand, is a source of both static and signal currents and the static currents therein may therefore be opposed to those in the "tether" and thus be annulled.

In point of explanation of the phenomenon of the pivoted antenna: It has been believed for some time that because the earth is not a perfect conductor, the wave front of horizontally propagated wireless waves may not be strictly vertical, but may be tipped forward or backward at an angle to the horizontal. Weagant was the first to prove this in practice, for he found that by tilting the antenna A-1 of figure 42 at various angles to the horizontal and pointing it in the proper direction, an angle can be found which presumably is normal to the wave front of the signals and at which the antenna will not pick up signals; but it continues to pick up static which was to be expected on the assumed theory of vertically propagated static waves. The "tether" antenna then becomes a static tank, but the correct angle, of course, must be found for each transmitting station in order that the tank will not pick up the signaling wave.

Mr. Weagant has found that the "tether" antenna determines the angle of the advancing wave with remarkable accuracy, it being possible to determine the position for minimum signals within one or two degrees.

To illustrate more clearly the assumed operation of the "tether" antenna, a possible direction of wireless telegraph waves is shown by the single pointed arrows in figure 42; the vertical propagated static waves by a number of double pointed arrows. When the "tether" antenna A is adjusted at a right angle to the actual wave front, no electromotive forces will be induced therein. The static waves, however, act upon the "tether" antenna and induce therein electromotive forces, the frequency of which can be adjusted to the same value as the frequency of the static currents induced in the receiving loop A-2. Since the loop antenna A-2 is a source of both signal and static currents, the static currents of the "tether" antenna A-1 may be opposed to the static currents in the loop A-2, retaining the signal.

The two antenna in figure 42 may be, of course, coupled through the agency of a goniometer to obtain the desired static balance. The diagram simply shows the fundamental connections of the circuit.

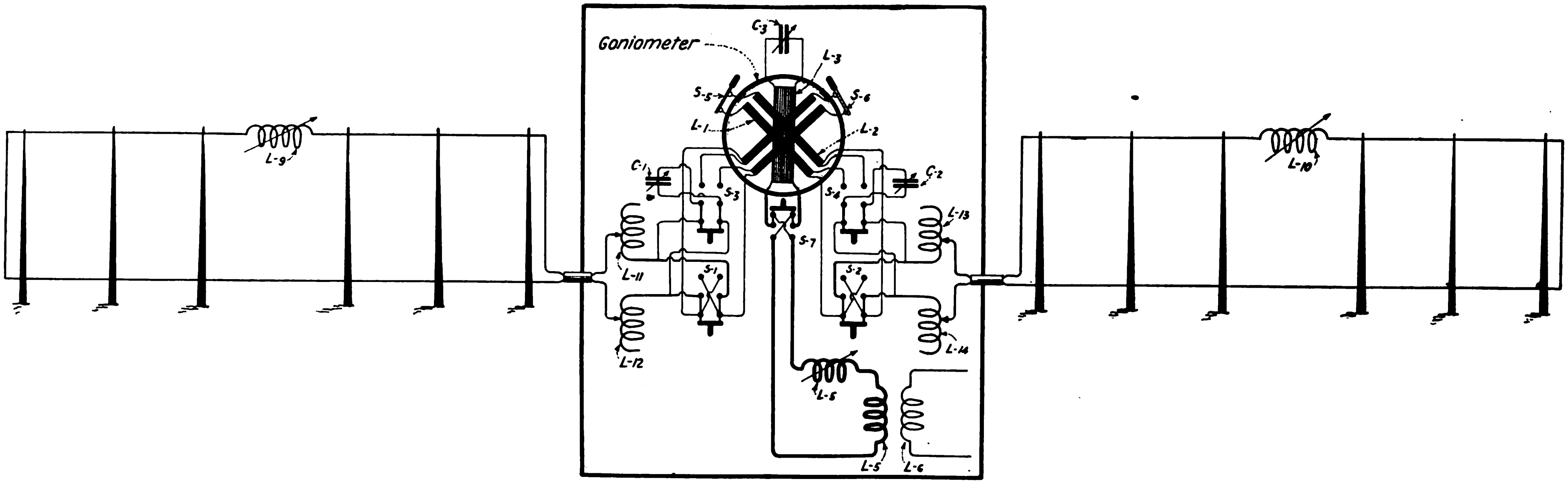


Figure 36—Complete circuits of the Weagant two-aerial system providing either series or parallel tuning. Switches S-1 and S-2 reverse the connection between the goniometer coils and the loops. Switches S-3 and S-4 place the variable condensers C-1 and C-2 either in series or in shunt with the stationary goniometer coils

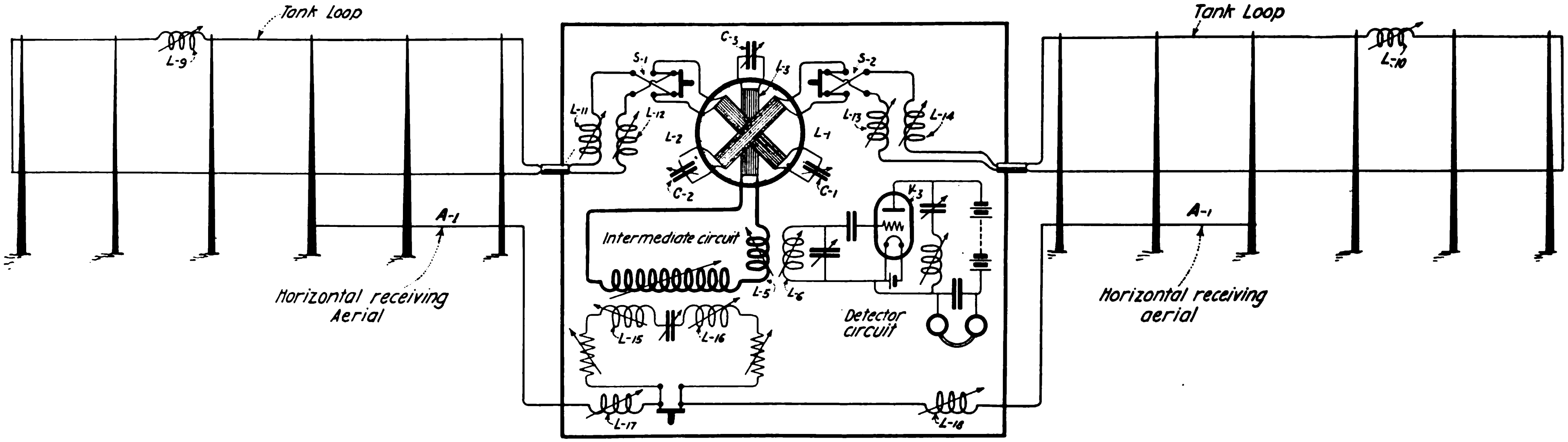


Figure 37—Fundamental circuits of the Weagant three-aerial system wherein two loops are used as a "static tank." This is the preferred method of annulling the interference of static waves. In accordance with the principle of this discovery two single turn loops are used in such a way that they become a source of static currents of any desired frequency but not a source of signal currents. The main receiving aerial is a long low horizontal wire A-1. This and the static tank are coupled to the receiving circuits within the station. The static tank is a source of static currents of both the clicks and grinders type. By proper adjustment of inductances, capacities and resistances in the static tank and the receiving aerial, and by finding a suitable position for the goniometer coil L-3, static currents of the frequency of those induced in the receiving antenna can be drawn from the static tank to balance out the static currents in the horizontal receiving aerial thus retaining the full strength of the signal current. So successful is this system in removing the most troublesome types of static interference that it permits 24 hour transoceanic wireless reception without interruption

It is to be noted that a condenser in dotted lines is connected across the tuning elements of the "tether" antenna. . This is the preferred connection for average working.

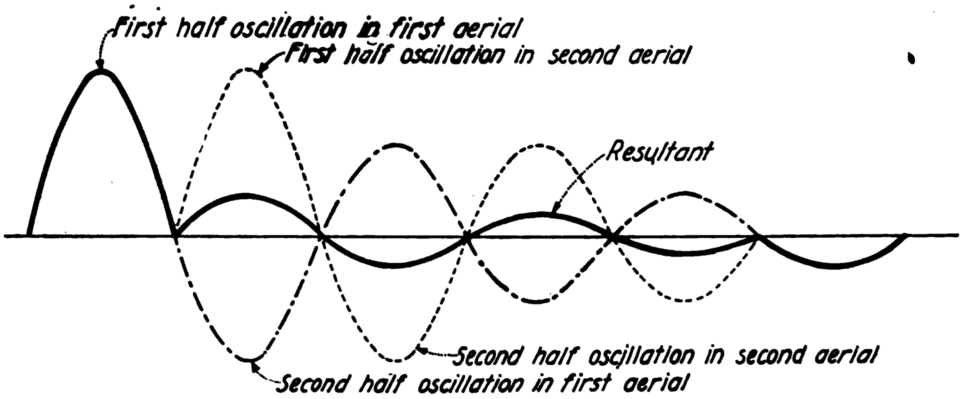

First half oscillation in first aerial
First half oscillation in second aerial
Resultant
Second half oscillation in second aerial
Second half oscillation in first aerial

Figure 38—Graphs showing how the Weagant static tank retains "clicks," a type of static which is assumed to be propagated horizontally as electromagnetic waves. It would appear that since the static tank balances out horizontally propagated signaling waves, it would affect likewise, horizontally propagated static waves; and as a consequence, the static tank would become only a source of "grinders" providing no means for balancing out the "clicks" in the horizontal receiving aerial. The fact remains, however, that the static tank picks up and retains the energy of both grinders and clicks as will be evident from the curve. It will be seen that because the horizontally moving static wave acts first upon one aerial and then on the other, the first half oscillation induced in the first antenna is unopposed. The second half oscillation in the first aerial, however, is opposed by the first half oscillation of the second aerial and so on throughout the wave train. The resultant of these two graphs obviously is not zero, and hence sufficient amounts of the static currents of both the clicks and grinders type are retained for balancing purposes

Owing to the very small length of the "tether" antenna A-1, large loading inductances must be inserted in the central point to obtain resonance with a transmitter operating at long wave lengths; and an eight-stage amplifier is required to bring the signals up to practical audibility. It is interesting to note that with an amplifier of such capabilities, when properly designed, a very small loop A-2 will give readable signals from high power stations several thousand miles distant.

A variation from the arrangement in figure 42 is shown in figure 43; here two pivotal antennae A-1 and A-2 are constructed as the "tether" antenna of figure 42 so that they can be placed at any angle in respect to the direction of the advancing wave. The antenna A-1 is then adjusted, let us say, to a certain angle with the horizontal so that it will be unresponsive to the desired signal. Next, the antenna A-2 is set at an angle to the horizontal so that it will be responsive to both static and signals. The antenna A-1 as before, constitutes, a static tank, whereas A-2 is a source of both static and signaling currents. Either of the antennae, of course, can be used as a static tank and the other as the receiving antenna.

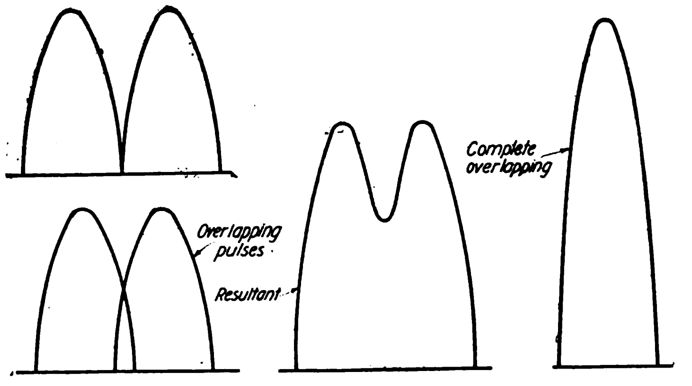


Figure 39—Upper left hand diagram. Showing the wave form of the resulting static currents in the Weagant static tank generated by "clicks" when the loop aerials are heavily damped by the insertion of resistances

Figure 39-A—Curves showing the wave form of static currents generated in the static tank by horizontally propagated "clicks," as the angle of the clicks increase in respect to the plane of the static tank

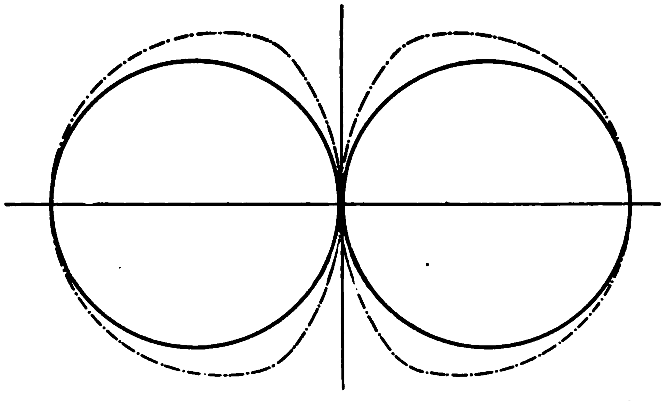


Figure 40—Reception curves of the Weagant static tank and the receiving aerial. The difference between the areas of the two curves shows the residue of static, which is practically negligible

By the use of multi-stage valve amplifiers to bring the incoming signals to audibility, such small antennae are perfectly feasible for the reception of radio telegraphic signals over great distances and it is quite possible that they will be employed in commercial practice.

Commercial Aspects

Only those who have been actively identified with the radio art through its progressive steps and have had the opportunity to observe for themselves the magnitude of the interference engendered by static waves, can realize the boon which the Weagant system has given to commercial long distance wireless telegraphy. With ordinary apparatus and aerials, continuous transoceanic working, particularly during the summer months, was impossible; but such reception is now possible not only with lesser amounts of power at the transmitter, but with a much less expensive antenna structure at the receiving station, giving a better static balance than that obtained with the former costly types of aerials with high towers.

No better estimate of the commercial practicability of the Weagant system can be given than that presented by the inventor himself. He said:

"Continued use has established beyond question that this performance is not occasional, or accidental; it is consistent. With this arrangement transatlantic radio telegraphy can now be carried on free from interruptions due to static of any kind whatsoever except local lightning. This cannot always be neutralized, but since the cables are also interrupted by this latter cause, it follows that a continuity of communication equal to that of cable operation is now possible by radio telegraphy, while the latter has the great advantage of cheapness and greater speed of operation. For many years attempts to work automatic high speed radio telegraphy have been made, but they have been successful only when static was absent. It is therefore evident that use can now be made of this method of working to a very great extent, thereby greatly increasing the number of messages which can

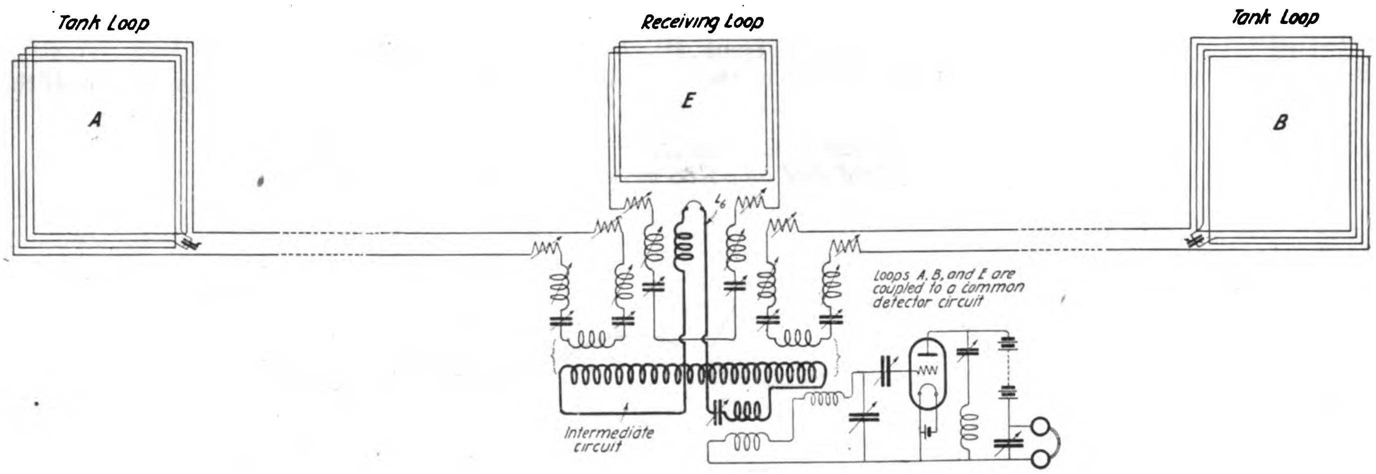


Figure 41—An early form of the Weagant static tank employing three cages or loop aerials. Loops A and B, separated several thousand feet are employed as a static tank and are coupled to the detecting apparatus in such a way as to build up the static currents and eliminate the signal current. Loop E is the receiving aerial which picks up both static and signals. The static currents flowing in the tank loops are balanced against the static currents in the receiving loop resulting in annulment, while retaining the signal

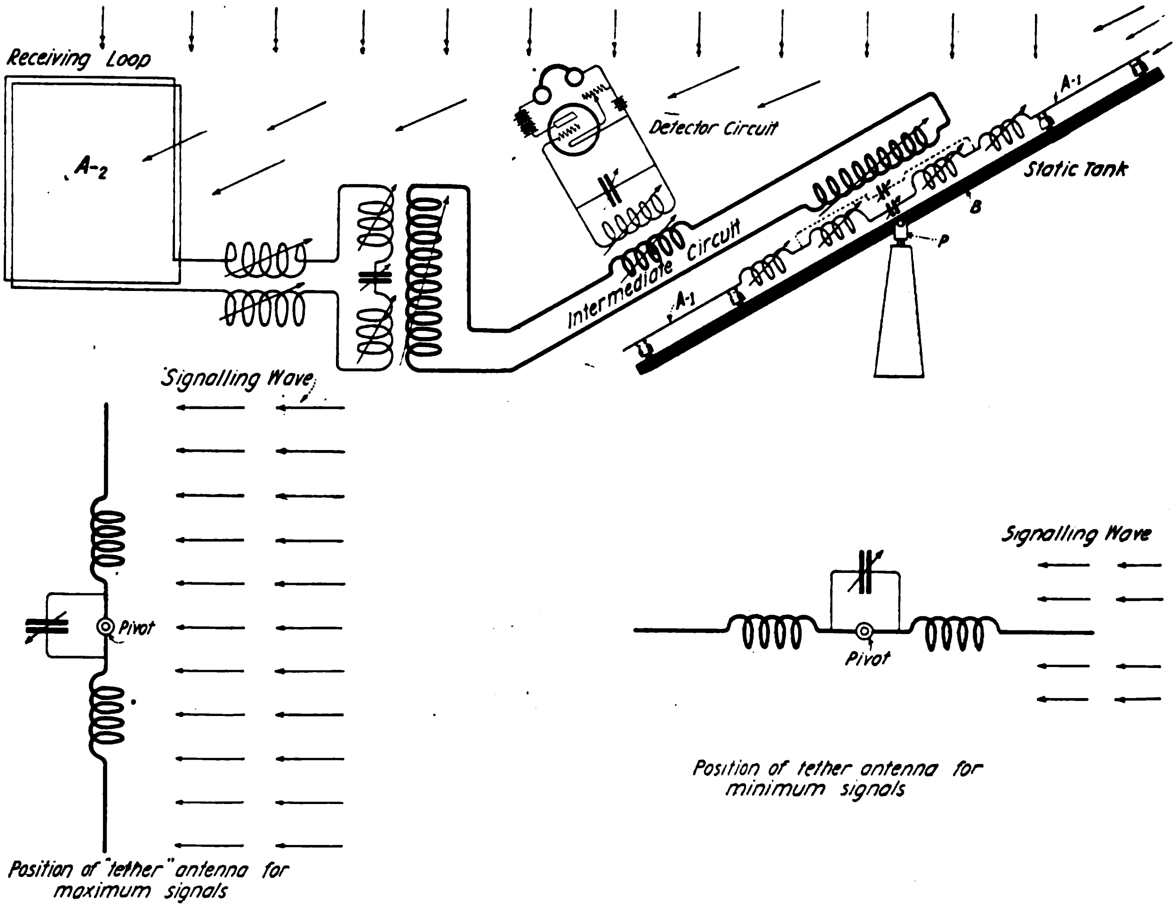


Figure 42—The Weagant "whippet" static tank—a discovery which presents some interesting novelties. In this system a horizontal aerial A-1, not over 25 or 30 feet in length is mounted on an arm B which may be revolved on a pivot P and placed at any angle in respect to the horizontal. The receiving loop A-2 is a closed coil of a few turns of wire, four or five feet square. Both aerials are coupled to a common detector circuit. By pointing the horizontal or "tether" antenna in the direction of the transmitting station and placing it at the correct angle in respect to the earth, a position can be found which is normal to the wave front, and at which the horizontal antenna will not respond to a given signal wave, but to static waves only. It thus becomes a static tank. The receiving loop collects both static and signals, and the static currents therein are balanced against those generated in the horizontal aerial.

Through the use of an ingeniously designed eight-stage amplifier the signals emanating from high power stations several thousand miles distant can be brought up to practical audibility with these antennae. In the diagram, the assumed direction of a distorted signaling wave is indicated by the single pointed arrows and the vertically propagated static waves by the double pointed arrows. It is readily seen that no electromotive forces will be induced in the horizontal antenna by the signaling wave, but it is acted upon by vertically propagated static waves. The two lower drawings show the position of the horizontal antenna for maximum and minimum signals be handled over a given circuit. It may also be stated that the great barrier in the way of successful, practical radio telephony has been removed since static has interfered with radio telephony to a much greater extent even than with radio telegraphy." This summarizes the practical values of the Weagant anti-static invention.

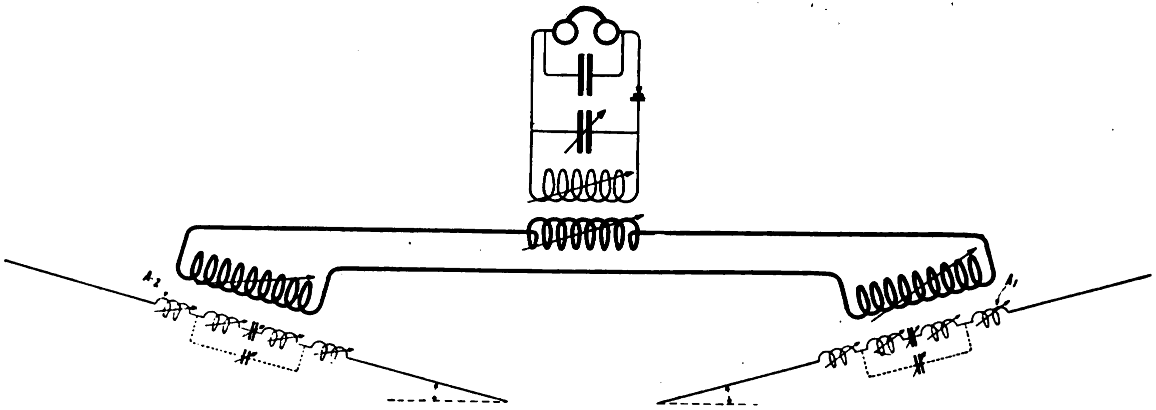


Figure 43—A modification of figure 42 where two short horizontal aerials are mounted on a "tether" arm, one being used as a static tank and the other as a receiving antenna. One antenna is set at such an angle in respect to the horizontal as to be responsive to both signals and static while the other is placed so that it is responsive to static only. Both antennae are coupled to a common receiving circuit wherein the static currents are opposed, the signal current being retained as in the several foregoing methods

Fuller's Method of Signaling with Arc Transmitters

During a sending period, the arc gap of arc transmitters must operate continuously. Signaling is accomplished by detuning the antenna circuit to a different wave length than that to which the receiver is adjusted. The usual method is to vary the antenna inductance by short circuiting a portion of the turns during the signaling periods. The antenna radiates a wave of one length when the key is depressed and a wave of another length when the transmitting key is open. A difference of 100 meters is generally sufficient for signaling. In high power transmitting stations large currents must be handled by the short-circuiting apparatus, and some difficulty has been experienced in opening and closing the circuits.

The well known method designed by Fuller provides an electromagnetically operated relay key which performs the function of short-circuiting a fraction of a turn of the aerial tuning inductances at several points.

Several turns must be short circuited by the multiple contact key in order to produce the desired change in wave length. By breaking the inductance into a plurality of sections, and short circuiting each section independently, only a portion of the energy impressed on the key circuit is handled by each contact. The energy handled by each contact is substantially constant, irrespective of whether the various circuits are opened simultaneously or at different times in any sequence. The preferred method of operation is, of course, to have these contacts open and close together.

In the diagram, taps are brought from the aerial tuning inductance 2 to various parts of the signaling key. The armature of the signaling key makes contact with the studs 15, 16, 17 and 18 short circuiting the turns and thereby changing the antenna wave length.

Fuller has disclosed other means of controlling the antenna current in an arc system as indicated in figure 2, in which a shunt oscillation circuit 12, 9 and 8 is connected across the arc gap proper 2. The spacing of the electrodes at 12 is preferably such that normally a very small amount of current will pass across the arc making the shunt circuit practically an open circuit and confining the oscillations generated by the arc 12 to the antenna circuit.

The resistance of the arc gap is preferably such that the current will spit across the arc gap spasmodically but will not flow continuously. Means are then provided for impressing an additional voltage on the arc 12, to reduce the resistance and form a shunt path for the current from the arc 12. The additional E.M.F. is provided by the DC generator 13, the circuit from which is closed by the key 14, the arc in which is extinguished by a magnetic blowout or other means.

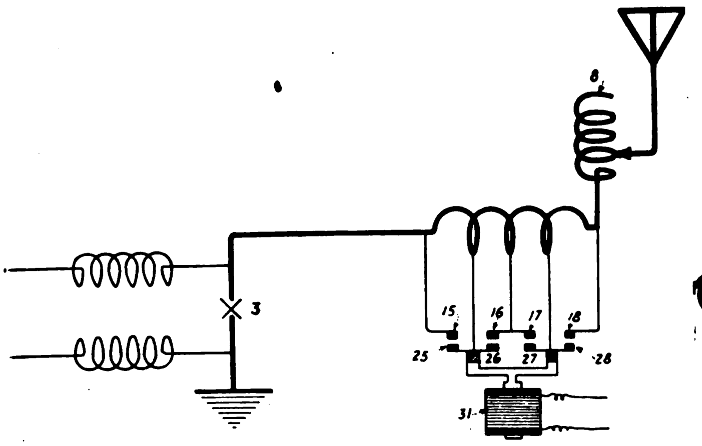


Figure 1—Diagram showing taps from the aerial tuning inductance to parts of the key

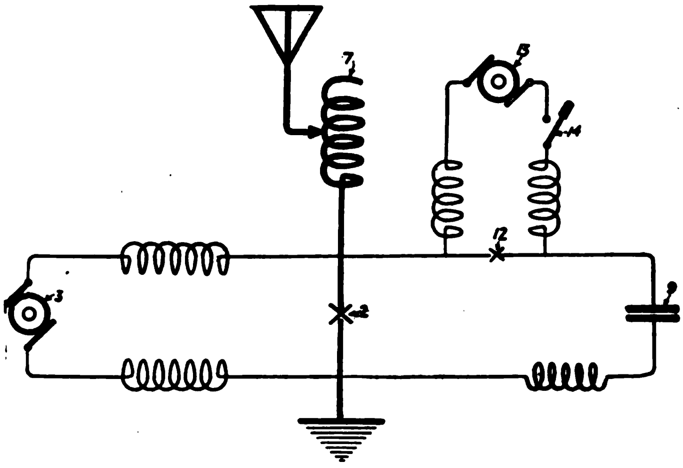
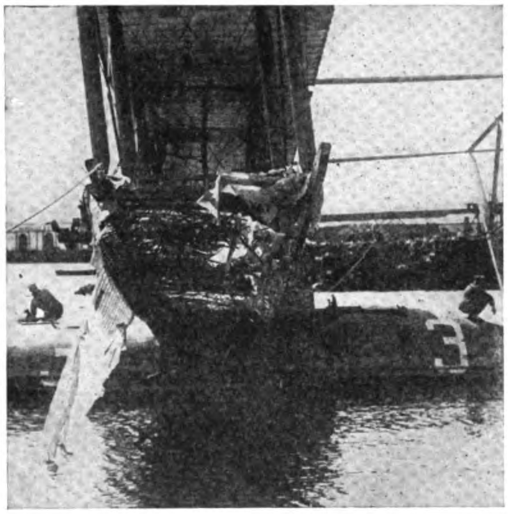


Figure 2—Diagram showing the use of a shunt oscillation circuit

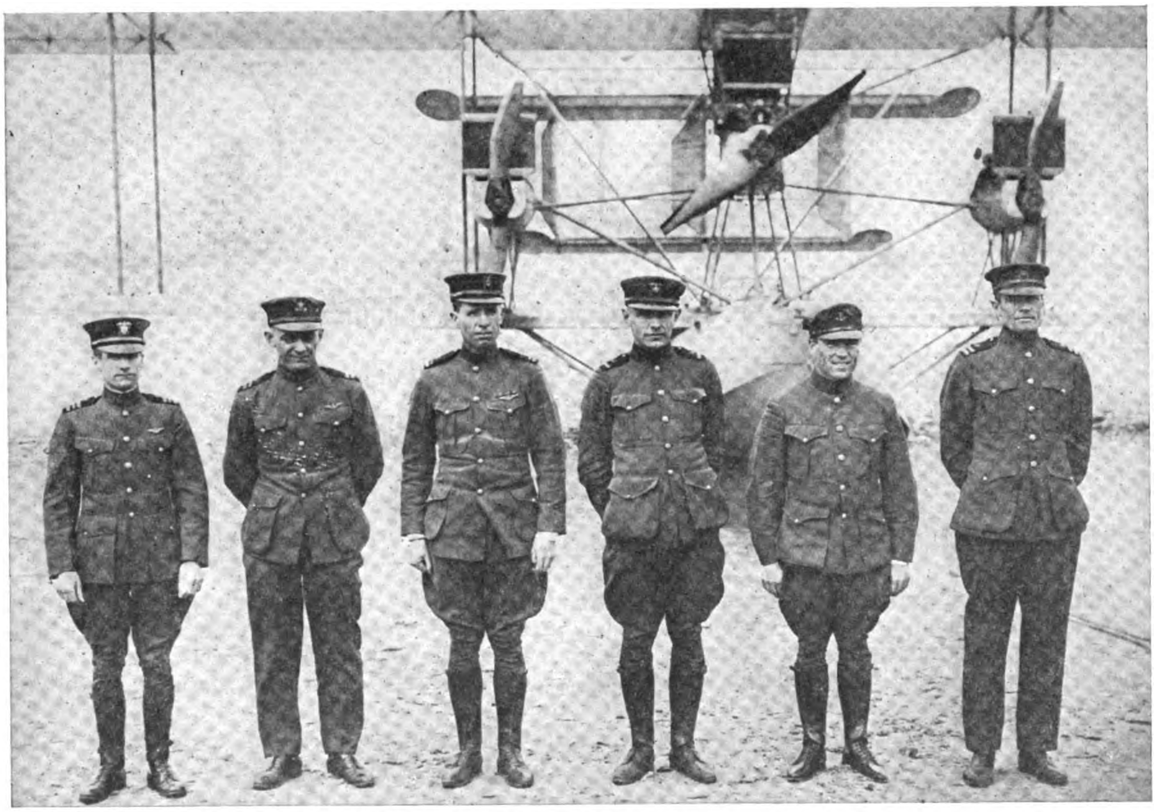
AIR MEN



Above: The NC-3 arriving at Ponta Delgada with lower wing damaged by the waves

To the left: Harry Hawker, the English aviator, who contested with American naval men the first honors of trans-Atlantic flight, but who was forced down in mid-ocean by engine failure

Press Ill. Svce.



The victorious crew of the NC-4, the first airplane to fly across the Atlantic; Ensign H. C. Rodd, wireless operator is fourth from the left. The others are, left to right, Lieut. Commander A. C. Read, commander; Lieut. E. F. Stone, pilot; Lieut. (j g) Walter Hinton, pilot; (Ensign Rodd) Chief Special Mechanic E. H. Howard, engineer (injured by propellor blade at last moment and could not go), Lieut. J. L. Breese, reserve pilot engineer

Cascade Amplification by a Single Vacuum Tube

A VACUUM tube for cascade amplification of variable E.M.F.'s without intervening transformers has been developed by Alexander Nicolson. The structure of the tube is shown in figure 1 and a circuit diagram in figure 2. The underlying principle of operation is as follows:

The input E.M.F. is impressed between the first section of the cathode and its associated input element, and serves to vary the discharge from the cathode section to another electrode which is maintained positive with respect to the cathode section. By inductively isolating it from the output circuit of the system, the electrode in question is made to function as an input element with reference to the second section of the cathode, and, by virtue of the varying charge delivered to it from the first cathode section, is made to vary the discharge from the second cathode section to a second electrode maintained positive with respect to that section. It, in fact, serves the double function of an anode for the cathode section and an input element for a third section.

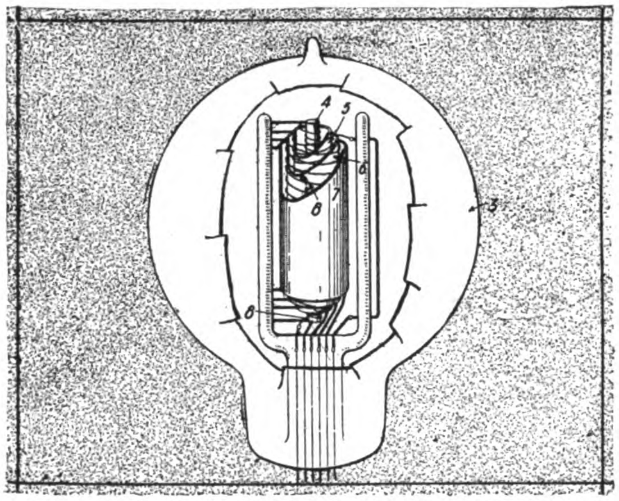


Figure 1—Showing the construction of the vacuum tube used in cascade amplification

Referring to figure 1, 3 is an evacuated vessel containing a group of concentrically arranged cylindrical electrodes 4, 5, 6 and 7. A filamentary cathode 8 is wound first about the outer surface of electrode 4, passing from electrode 4 to electrode 5 and from electrode 5 to electrode 6 and from electrode 6 to the leading-in wire.

The electrodes 4, 5, 6 and 7 are preferably made of nickel, and in the case of 4, 5 and 6 the outer surface is oxidized so as to form a dielectric or insulating film between the cathode filament 8 and the electrode on which the filament is wound.

The operation of the device as an amplifier will be more clearly understood by reference to figure 2. In this figure 8a is that section of the filament which is wound around electrode 4; and 8b and 8c are those sections which are wound on electrodes 5 and 6, respectively. The filament 8, as a whole, is heated to incandescence by a battery 15 and the input is impressed between this filament and the main input electrode 4 by means of the transformer secondary 17, the primary 16 of which is connected to the source of telephonic or other currents of varying frequency to be amplified.

The electrode 5 which is maintained positive with respect to the cathode section 8a by battery 18 serves as an anode with respect to this cathode section and with respect to the input electrode 4, and receives a varying charge by virtue of the variation in thermionic current flowing from the cathode section produced by the input E.M.F. The electrode 5, instead of being directly connected to the output circuit, as in former audion arrangements, is here inductively isolated therefrom by the impedance coil 19. The varying charge thus received by electrode 5 causes it to act as an input electrode for the cathode section 8b by varying the thermionic current from that cathode section to its inclosing cylindrical electrode 6. The latter in turn is inductively isolated from the output circuit by impedance coil 20 and serves as an input electrode for the cathode section 8c. The anode 7, associated with this cathode section 8c is included in the output circuit which comprises transformer primary 21, batteries 22, 23 and 18, and cathode 8.

It is important that in the arrangement shown the filament section 8a be connected to the negative terminal of battery 15 and that section 8c be connected to the positive terminal of the battery. Thus, because of the potential drop in the filament 8 as a whole due to the flow of heating current through it, the section 8a will be more negative with respect to electrode 5 than will section 8b, and similarly, section 8b will be more negative with respect to electrode 6 than will section 8c.

In the particular arrangement depicted the input energy is subjected to three distinct stages of amplification by what is the equivalent of three distinct audion arrangements. The first of these arrangements comprises electrode 4 as an input electrode, filament section 8a as cathode and electrode 5 as anode. The second, comprises electrode 5 as input electrode, filament section 8b as cathode and electrode 6 as anode, while the third comprises electrode 6 as input electrode, filament section 8c as cathode and electrode 7 as the final anode and output electrode. The battery 23 makes anode 6 more positive than anode 5, while anode 7 is more positive than anode 6 by reason of battery 22. Each anode is thus more positive than the one preceding.

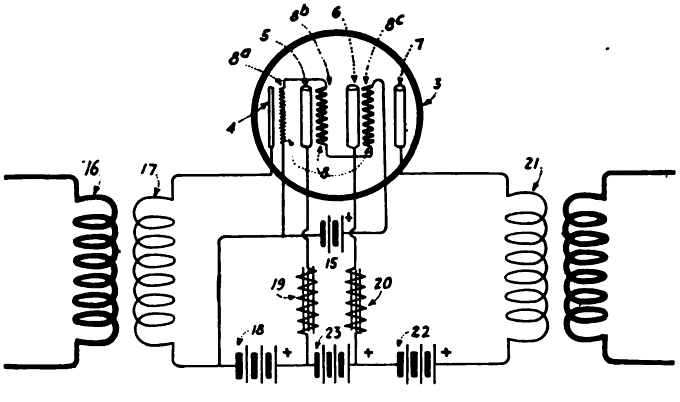


Figure 2—Diagram of circuit used in cascade amplification by a single vacuum tube

Hammond's Method of Modulating Antenna Current

It is generally understood in the art of radiotelegraphy that if a properly designed undamped wave transmitter and receiver are operating in resonance, a change in wave length of 1/10 of 1% at either the transmitting or receiving station will destroy the condition of resonance between them. Any device which will provide the necessary change of wave length at audibility rates may be employed for telegraphic signaling.

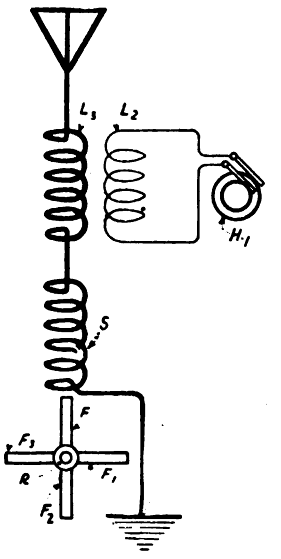


Figure 1—Illustrating the method used to vary the antenna circuit inductance

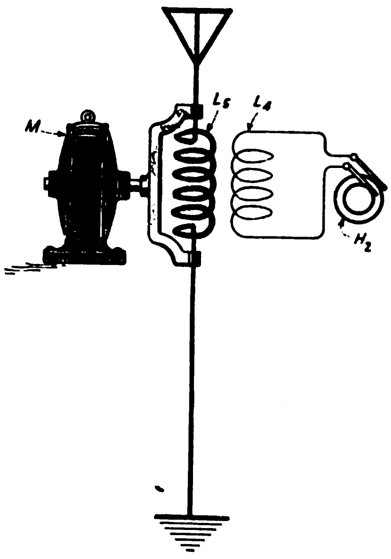


Figure 2—Showing method of controlling the output of the alternator

The necessary change in wave length may be produced by changing either the capacity or inductance of the oscillatory circuit. In fact, if a change of 1% be made in either the capacity or inductance of the transmitter, a change of perhaps 100% may be caused in the intensity of the received signals at the receiving station.

By periodically varying the capacity or inductance at a transmitting station such as shown in the accompanying figures 1 and 2, it is possible to produce at the receiving station an impulse of a sinusoidal character.

Hammond claims to have discovered that the variation produced in the transmitting apparatus to give signals at audio-frequencies is preferably of a very peaked form rather than of a sinusoidal form, the reason being, that due to the resistance of the receiving circuits, there is a tendency to flatten out the wave form. Therefore, to produce sinusoidal waves at the receiving station a very peaked wave form is necessary at the transmitting station.

In figure 1 a method of varying the inductance of the antenna circuit is shown. The high frequency alternator H-1 impresses undamped oscillation upon the antenna circuit through the coupling L-2, L-3. Another inductance S is included in the antenna circuit which is in magnetic relation to a rotating element R having pole pieces F, F-1, F-2 and F-3. As R is rotated, periodic variations of the inductance of S occur causing the antenna circuit to be thrown out of resonance with the high frequency alternator. The periodicity of the amplitude variations thus produced depends upon the speed of the rotating element R and upon the number of its pole pieces.

In the diagram of figure 2 the coil L-5 is mechanically attached to the motor M and rotated in respect to L-4 so as to vary its inductive relation. In this way, the amplitude of the antenna current is varied periodically at any desired frequency and the output of the alternator H-2 in accordance.

Methods of Varying Antenna Currents in Radio Telephony at Speech Frequencies

It has been found, in attempts to develop the art of radio telephony, that a serious limitation has been imposed by reason of the fact that any telephone transmitter at present known to the art is incapable of handling all the energy which is required for successful modulation of high frequency power for commercial radiotelephony.

H. J. Van der Bijl has devised several ways by which antenna currents are varied indirectly by a microphone and associated circuits employing the magnifying properties of vacuum tubes. The method depends upon the fact that an electromotive force impressed upon the input circuit of a thermionic amplifier of the "audion" type produces an apparent change in the impedance of its output circuit; in particular, a change in electromotive force impressed upon the input circuit, resulting from a change in impedance in a local circuit associated with the input circuit, causes the impedance of the output circuit of the amplifier to vary in such a way as to produce therein much greater changes in power than take place in the above mentioned local circuit. The thermionic amplifier in this case acts as a magnifying device for changes of power in the local circuit, and on account of this property a primary source of modulated power, capable of handling only a small amount of power, may be used to produce much larger changes in the transmitting antenna.

A variable impedance path, for example, the output circuit of a thermionic repeater is inserted into the transmitting antenna carrying high frequency currents, and thereby producing large changes in radiated power at the expense of but small changes of power in the telephone transmitter.

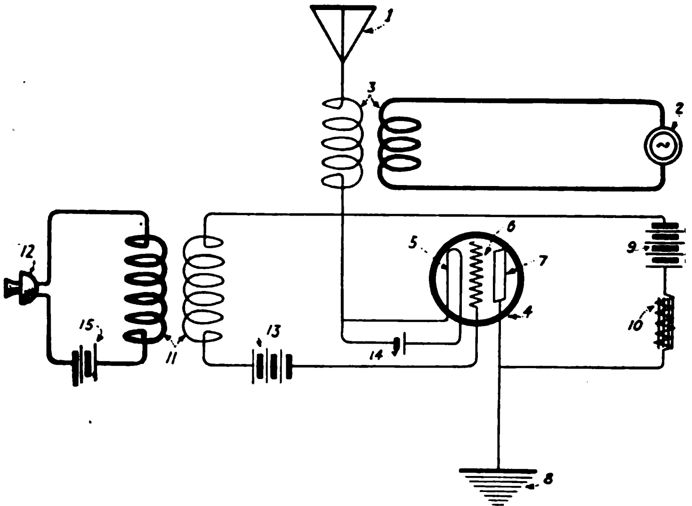


Figure 1—Diagram of a circuit used to connect an amplifier in series with an antenna

Figure 1 shows a method of connection of an amplifier in series with an antenna; figure 2 represents a preferred form which is better adapted to the modulation of large amounts of power, such as would be required in commercial operation; and figure 3 shows another method of placing the amplifier effectively in series with the antenna by means of a transformer.

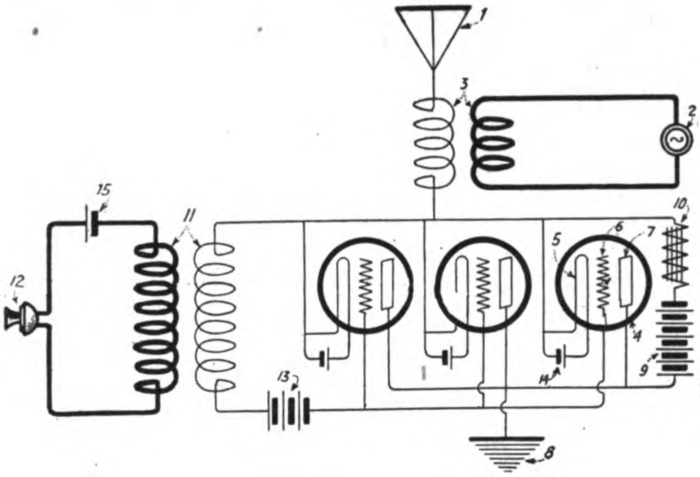


Figure 2—Another form suitable for the modulation of large amounts of power

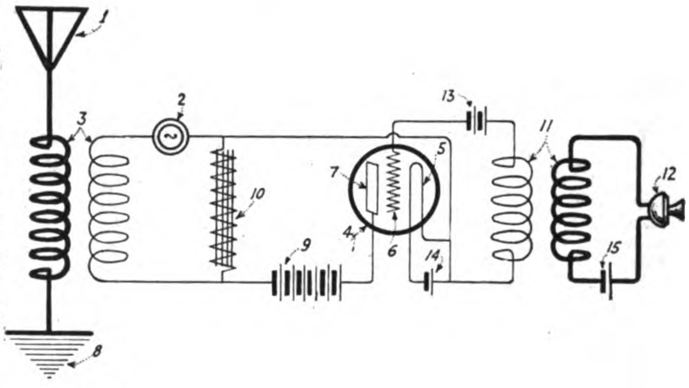


Figure 3—Method of placing the amplifier effectively in series with the antenna by means of a transformer

Referring to figure 1, 1-8 is an antenna, 2 an alternator or other source of high frequency currents; 3 is a transformer between the antenna and the generator 2; 4 is a thermionic amplifier of the "audion" type having an electron-emitting cathode 5, a grid 6 and a plate 7. The antenna system is earthed at the point 8. The plate circuit is completed through the choke coil 10 and the battery 9. A transformer 11 serves to impress upon the input circuit of the amplifier variations in electromotive force caused by the microphone 12 in the local circuit. Batteries 13 and 14 are connected as usual in the operation of the amplifier, and battery 15 supplies current to microphone 12.

An objection to the circuit shown in figure 1 is that the output impedance of the thermionic amplifier, as at present constructed, is so high that it cannot be efficiently inserted directly into an antenna circuit. To overcome this difficulty, and to provide also for the modulation of larger amounts of power, a number of these elements may be connected in parallel as shown in figure 2, in which corresponding parts are denoted by the same numerals as in figure 1.

In figure 3, the variable impedance of the output circuit is placed directly in the generator circuit, but since that circuit is coupled to the antenna by transformer 3, this output circuit is effectively in series with the antenna and generator, since an impedance that is connected into a circuit by means of a transformer is equivalent, for forced oscillations, to a certain other impedance connected directly into that circuit. The function of the choke coil 10 is to exclude direct current from the generator 2.

The operation of the system is as follows: The generator 2 impresses high frequency power upon the antenna. Due to the choke coil 10, practically the whole of the high frequency current must flow through the amplifier and is superposed upon the space current of the amplifier. The choke coil is necessary in order to provide a conducting path for direct current in the output circuit. A variation in resistance in the microphone 12, due to voice waves impinging upon it, causes an electromotive force to be impressed upon the input circuit, which, in consequence of a well known property of the amplifier, produces an apparent change in the output resistance of the device, this change in output resistance causing a change in the amplitude of the high frequency antenna current.

Radio Call Apparatus

When continuous waves are employed for wireless transmission, it is often desirable to use very accurately tuned and highly selected receiving apparatus. This increases the liability of missing communications because a slight difference in the tuning of the receiver and transmitter, with continuous waves, completely eliminates the signals. In order to call the attention of a receiving operator whose apparatus is adjusted to a different wave length than that at which the transmitting station desires to work, John St. Vincent Pletts has devised the calling apparatus shown in figure 1.

It consists of a variable condenser H, a variable inductance F mounted on the shaft B coupled to a mechanical oscillatory system comprising a fly-wheel C and a spring D. If this device is connected in a wireless transmitter circuit and caused to oscillate mechanically, as by rotating the wheel, waves may be sent out which at first vary over a considerable range of frequencies and then over a smaller and smaller range until the wave length becomes constant. Such waves produce a distinctive sound every time they come into tune with a receiver and attract the attention of the operator, even though his receiver is not accurately tuned to the normal wave length of the transmitter.

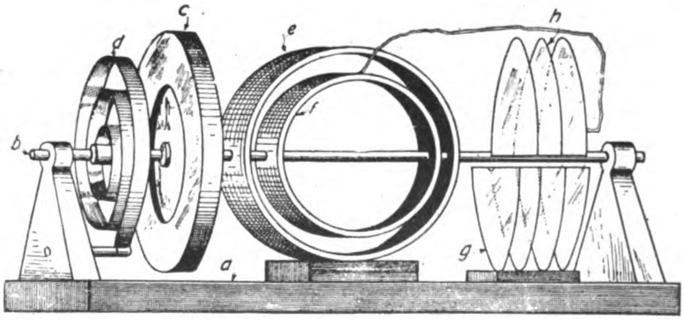


Figure 1—Showing the design of the radio calling apparatus

Undamped Wave Reception at Very Short Wave Lengths

IN receivers based on the interference or beat principle it is usual to employ a local oscillator which can be so adjusted as to produce oscillations differing in frequency by a desired amount from the oscillations produced in the receiver by the incoming waves. In some vacuum tube circuits the receiving device is its own local oscillator. The result is that during reception there are in the receiving circuits two sets of oscillations which interact with each other, producing a compound oscillation of varying amplitude. The receiver usually rectifies this compound oscillation into a uni-directional current of varying strength and so produces in the receiving telephone a note which has a frequency equal to the difference of the frequencies of the received and local oscillations.

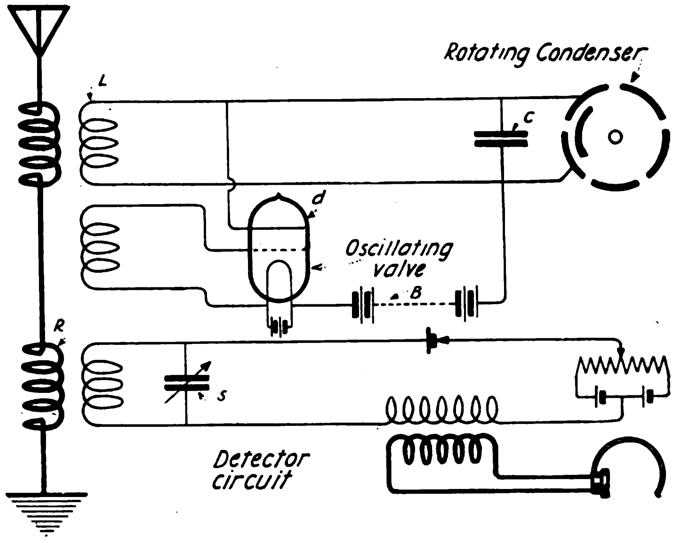


Figure 1—Circuit used in the new method of regularly varying the frequency of the local oscillations to permit undamped wave reception at short wave lengths

The constancy of the note depends upon the constancy of the frequency of the received and local oscillations. For frequencies below about 1,000,000 per second (300 meter waves) it is not difficult to maintain a sufficiently constant frequency; for frequencies about 3,000,000 it is still practicable though not easy to maintain a sufficiently constant frequency; for frequencies about 30,000,000 it is practically impossible to maintain the frequency sufficiently constant.

Assuming 30,000,000 to be the frequency received, then the local oscillator must generate a frequency of 30,001,000 or 29,999,000, in order to give an interference note of 1,000. Should either frequency vary one hundredth of one per cent, the interference note may change from 1,000 to 4,000. Practically when working with frequencies of this order the interference note varies so rapidly and to such an extent with the small variations of frequency which take place that the signals are unreadable.

In a new method devised by C. S. Franklin, the frequency of the local oscillations is varied by a small percentage, regularly and in a continuous manner. This may be done by arranging in the local generator a rotating condenser which consists partly of segments arranged on a rotating disc or cylinder, so that the capacity varies continually between two limits.

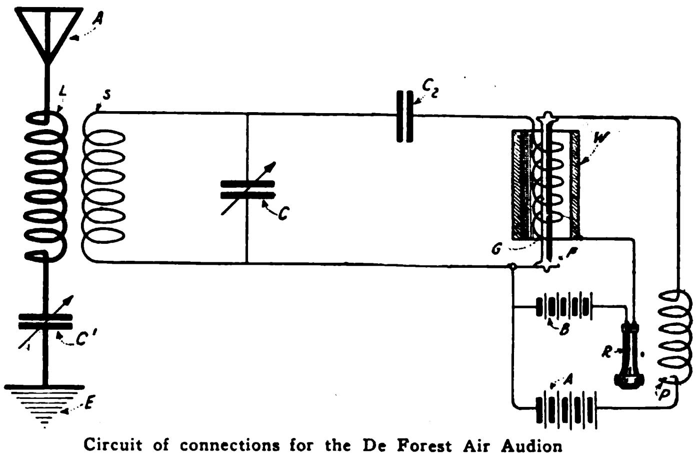
The circuit shown in figure 1 works as follows: Assume the received frequency to be 30,000,000 and the local generator arranged to give a 30,000,000 frequency with variations of a half per cent above and below this, 1,000 times per second, produced by the revolving condenser. During reception an interference note is produced which varies from zero to a frequency of 150,000. An audible sound is produced in the telephone only during the time that the interference note is varying through the range from about 8,000 to zero and back to 8,000; that is to say, while the interference note is within audible limits. The period occupied by this range is so short that only a "click" occurs in the telephone for every variation between the above limits of the frequency of the local oscillator. As, however, this variation occurs 1,000 times per second, a clear note having a frequency of 1,000 per second is heard whenever signals are received.

A receiver for short waves is thus obtained which has the great sensitiveness of the interference receiver, but is independent of very small variations in frequency either in the received waves or in the local oscillator.

De Forest Air Audion

LEE DE FOREST now claims that it is possible to receive radio telegraphic signals by means of a thermionic detector which operates in the open air. In the diagram figure 1, W is a plate which surrounds both the grid and filament electrodes. R is a receiving telephone connected in series with the B battery as in the usual circuits for the three electrode valve. G is the grid electrode which is wound around the filament F, which is a Nernst glower energized by an "A" battery with an impedance coil P in series.

The operating characteristics of this oscillation detector have not been disclosed, but will no doubt be forthcoming in the near future.



Circuit of connections for the De Forest Air Audion

A Summer on the Great Lakes

Some First Impressions of a Novice In Commercial Wireless Operating

By Julian K. Henney

I—Mal de Mer

As I sit here by an open window listening to the deep-throated blasts of the first freighters of the season, I cannot help but think of the pleasant summer I spent on the Great Lakes last year. The thought comes to me that after all has been said and done, the best positions in the world are not tnose that have the highest salaries attached to them, but those which bring the greatest amount of pleasure and satisfaction to the men who hold them. Personally, I believe that right now I should much rather be a radio operator on the ugliest freighter in the world with the ordinary wireless man's salary, than the president of Germany or the Great Mogul of Hindustan, with the accompanying millions and minions. In fact, I should rather be boss over one measly bellhop than commander-in-chief of an army that was only looking for a chance to put the transformer terminals around my neck. This, however, is entirely a personal opinion and has little to do with the recital of my experiences on the Great Lakes.

After several days of waiting at the Marconi offices in Cleveland, I was assigned to the Juniata with Watson Snell as partner. I knew in advance that the Juniata was a pretty ship and the run from Buffalo to Duluth one of the longest on the lakes, so I was rather elated at being placed as I was. Snell had been on the same steamer the season before, so I imagined we would soon get acquainted with the officers and crew.

We did . . . and quite suddenly too.

We started on the first of July for Buffalo, where we were to board the steamer which left on the second. Both of us were not sorry to get started, incidentally, for the tariff on board and rooms in Cleveland is slightly higher than on shipboard; so as soon as our passports to Buffalo had been issued, we lost no time in getting to the Seeandbee.

We had first, of course, carefully stowed away our tickets in the unhandiest possible pockets, received our death certificates—as the operator terms his insurance policy—our water front passes, a letter of introduction to the skipper of the Juniata, several words of advice from the traffic manager and the superintendent of the company, supplemented with orders to be careful about jamming the new navy men. With this equipment we started for the steamer, prepared to spend a pleasant evening on the way to Buffalo where our "six on and six off" started in earnest. Learning that we were to sleep in the radio man's bunk while he was on duty during the night, both Snell and myself had visions of a wonderful snooze while the great side-wheeler rushed us toward our own steamer.

All day long the wind had been whipping the shallow waters of Lake Erie into one of those choppy seas which are characteristic of this body of water, especially in the early part of July. The waves could be heard coming over the breakwater as we lugged our grips to the dock where the Seeandbee was tied up, and it was with the greatest of difficulty that Snell managed to keep his straw hat firmly anchored to his head. As gusts of wind tore past my singing ears and stinging cheeks, I looked out of the corner of my eyes—at intervals when the tears were not running out of them like a miniature St. Mary's Rapids—to see if that straw bonnet was still jauntily perched on the side of my worthy partner's head. This reconnaissance work was fascinating. For the hat stuck to its perch marvelously, much to my enjoyment at the time, but to my later embarassment. About every ten steps Watson would come to a groaning halt, methodically set down his suitcase, his kodak and his mandolin, thus freeing a hand to pound the hat down over his ears, while I trudged valiantly onward toward the pier with a half-ton hand trunk to impede locomotion.

But all thought of high seas, higher wind, and worries in general, left our minds as we lugged our dunnage aboard the Seeandbee and up a half-dozen flights of stairs. We walked up one corridor and down the other, vainly seeking the radio room. Our luggage became heavier and heavier. Several aeons, or ages, or something passed; but at last a kindly disposed bellboy pointed out the locked door of the wireless room. We deposited our paraphernalia outside the entrance, and waited. After sitting on the madolin and the hand trunk, respectively, for a half-hour, Snell and I decided that the radio man was not coming, and that we would have to sleep on the floor or invest three-fifty in a stateroom. Upon reflection, however, neither scheme appealed as being particularly practical; so we sat and waited.

While thus in repose, tied up to the mandolin and the traveling bag, we could fully appreciate that the wind was whistling overhead in the rigging, and occasionally we would hear a sickly groan as the steamer leaned over and rubbed against the pier. We were still inside the breakwater, but whenever a hard gust struck the vessel she lurched and strained ominously at her hawsers. . . . We began to wonder if it would not be better to go by train to Buffalo, and not take chances on the Seeandbee's going down.

With each rise and fall of the ship under us, we looked —not at each other—but out of the porthole, estimating the desirability of the New York Central as a common carrier, rather than the Cleveland and Buffalo Transit Company. But we sat on mandolin and traveling bag, and waited. It was here that Watson told me he intended to learn to play the staunch musical instrument, and he also confided that he had paid as much as a dollar and a half for the affair. Potentially, it was a good investment, for when I later heard him learning to play it, I offered him ten dollars to throw it and his musical aspirations overboard. He refused; doubtless reflecting upon the mandolin's one-time utility as a mourner's bench.

Nevertheless, about ten minutes before sailing time the radio operator appeared, and strange to say he seemed quite pleased to see us. I forget his name, so the designation of Jones will have to serve the purpose of this narrative.

Jones was a pretty good chap. He was not specially enthusiastic about us sleeping in his bunk, but he did not object. He eyed our impedimenta with a wary eye, but my pardner and I were nothing daunted. We were to sleep in his bunk; we intended to stow our stuff in the wireless room; and there we were; there could be no arguing about it. Jones could hardly have been pleased to hear what he soon learned: that I was from Western Reserve University. He came from Case School, my college's mortal enemy, so I looked for a rehearsal of the Thanksgiving game on the spot. But, as I say, Jones was a pretty good chap.

At eight o'clock the steamer cast off, and soon we were on our way down the waterfront, inside the long breakwater that protects Cleveland's shipping from the choppy seas of Lake Erie. I had been rather apprehensive as to what would happen when we got out in the open, and my fears were realized with interest as soon as the Seeandbee poked her nose into the gale.

A huge roller took us off the port bow, twisting the ship from stem to stern; a gust of wind took a slap at the upper works at the same time. The vessel rolled over with a snap; I rolled to the floor; Snell rammed his head into the bunk, and Jones got white around the mouth.

When a fair equilibrium had been established the long-looked-for question came forth.

"Do you fellows get sick?" inquired Jones, and there was a slight suggestion of loftiness in his voice.

I was fully prepared to answer. I would play safe. "Well, I never have yet," was my reply.

Snell adopted a superior tone. "Oh no, not me," he replied. "I spent all last summer on the Lakes and never even felt bad. I guess a little thing like this won't bother me." His manner reminded me of how his hat had stuck on his head with a sort of summery jauntiness that riled one all up. We were quiet for some time, trying to adjust ourselves to the twisting of the floor under our feet. Finally: "How does it feel to be sick, I wonder," speculated Jones.

"I don't really know," said Snell, "that is, from experience; but they say you feel kind of hollow down in your hold, and then in the galley it feels . . . well your dinner kind of. . . . I believe I'll turn in and get some sleep!"

Snell made a motion as if to enter the bunkroom door, but catching my eye, decided to stick around. Jones kept up his searching investigation into the subject of seasickness. He might have been intending to write a book about it from the interest he showed in Snell's answers.

"The mate tells me that even skippers and mates get sick some times when it is rough," was one of Jones' observations which I recall.

"Yes I've seen it so rough that even the Old Man had to stay in bed," agreed Snell. "But this little sea tonight is nothing to what you get in Lake Superior." I felt that this was a jab at me. "Are you having any success with the outfit this year? I used to hear the spark up North once in a while."

"Why yes, I guess so," said Jones. "You see I've only made a few trips. I never got sick yet. But then it has never been so rough before."

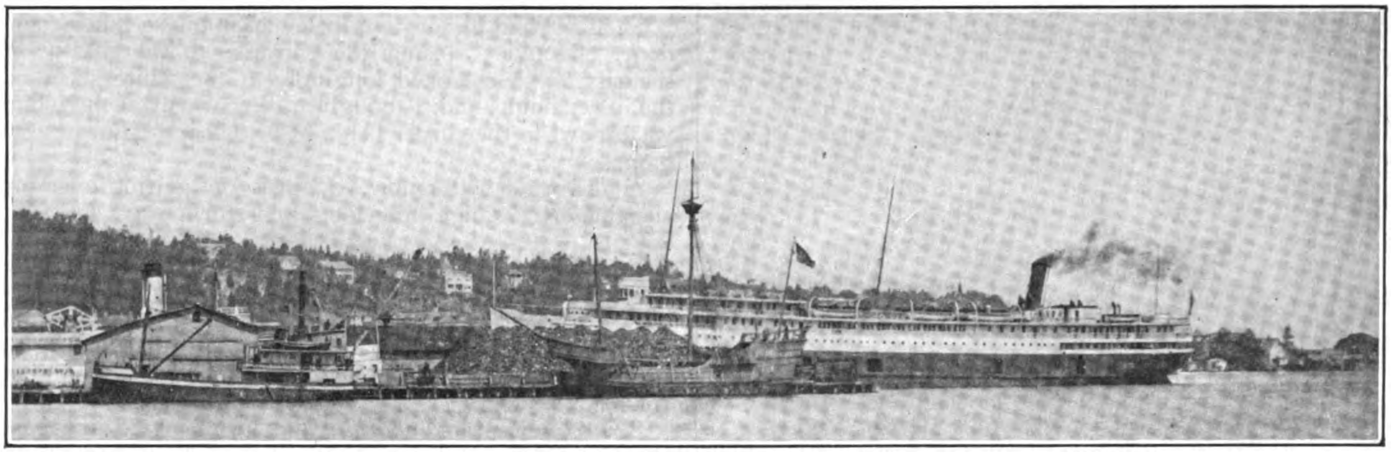
"Do you know Dietsch of the Detroit Third?" Snell tried again to change the subject.

"Yep, Dietsch has a pretty good fist, hasn't he? . . . You know, I'd hate to get sick on this tub. . . . What is a good thing to do for seasickness?"

About this time my mind's eye began to open. It became evident that the great wireless operator of the wonderful ship Seeandbee, the man who held the lives of all the ship's passengers in his hand, was worrying about something.

I shall never forget the little tableau which was then enacted in the radio cabin of the huge sidewheeler. Jones was at one end of the long room, perched upon the top of a high stool, the receivers over his ears, trying his level best to stick on the seat and to appear unconcerned. All his energy was needed to keep from sliding off on the floor with each lurch of the vessel, and he was continually sticking out an arm or leg to hold himself from the opposite wall. Snell stood in the doorway to the bunk room with a queer look in his eyes, one of which I could now interpret. I sat at the far end of the room in the dark, listening to the learned discourse on an ailment the existence of which, tradition records, has never been voluntarily admitted by those who acquired it. That night I discovered the only real preventative for the dread malady. I sat in the one chair that did not wobble and which had

Dark clouds sweeping by made us fully appreciate that the wind was whistling overhead in the rigging



The old and the new furnished a contrast when one of the massive modern Lake steamers nosed in behind a replica of the Santa Maria, the ship of Christopher Columbus

arms, my feet cocked up on the end of the operating table, my head resting on the back of the chair. In this position my body made a large V, with my "hold," as Snell called it, clear at the bottom. I was able to keep from falling on the floor at each lurch of the ship, and after a while I discovered that I did not observe that queer "elevator feeling" as the vessel rose and fell with the waves. I really felt fine, and was beginning to enjoy the affair to the limit. Catching Watson's eye, I nodded that I was on to his curves and immediately began to take an active part in the discussion.

"By the way, Jones, old man, you don't feel bad?" I asked.

"No indeed! Do you?" he replied. Then he added: I—I don't look sick, do I? Of course I could turn in if I got sick. I don't have to stay on the job if I am not able. I could turn in for a while and then—"

"Aw, you fellows can this 'sick' business! You make me tired! Use a little domestic science—" Snell was evidently rattled—"Why do you talk about it? If you're going to get sick go ahead; but quit thinking about it. Just because you feel kind of funny in the stomach is no sign—Ha, ha! Guess I'll turn in and get some sleep."

Snell turned again toward the bunks and I thought for a minute that he was going to desert me. But he had a new thought. Blandly, he asked if I were hungry. I immediately suggested that the three of us go down to the buffet and get something to eat. Jones looked horrified.

"Oh no, I can't leave the outfit," said the radio man. "I'd like to go, but something might happen."

So Snell and I made our way down to the lower deck and aft to where the buffet held forth with everything under the sun that was not good for one to eat. By holding on to the rail around the counter we managed to put down several shredded wheats and some coffee. A portly gentleman then staggered in and devoured a sardine sandwich and a bottle of ginger ale. We decided that the combination was the very thing for our friend up on top, and soon after we returned to the scene of action, properly equipped.

When we first glanced through the door the Case man who had turned wireless operator had his head on the table, pillowed in his arms. Snell coughed. Immediately, I opened up thus:

"What's matter, old man? Not sick in a little sea *like this are* you?"

"Nope," was Jones' energetic response. "I'm feeling a little sleepy, tho. And I can hear anything that comes in by putting on the receivers once in a while. It really isn't necessary to listen in all the time."

Snell turned to me. "By George, Henney," he volunteered. "I believe those bellhops down below were sick. Did you notice how sleepy they were?" He was quick to follow up this new avenue of attack. "Sleepiness is the first symptom, you know," he added seriously.

Poor Jones fell for the bait at once. "Is that right? But then, I haven't been getting much sleep lately. Guess that's why I am drowsy. How were the bellboys acting? Did you say they were sleepy?"

During the interchange, my friend Watson and I had firmly seated ourselves in the two good chairs, our feet high up in the air and our bodies in that comfortable and secure V position which I had discovered and passed on to Snell. But the poor Case man, he of the wonderful ship Seeandbee, was perched high up in the air on a rickety, swaying stool, the light of the lamp hanging over the operating table making clear every expression of his countenance. His feet were hitched in the rungs of the stool on which he was so precariously seated, and although he tried to conceal it, we could see that his hands were spasmodically twisting and turning, one to his stomach and the other to his mouth, as if he was expecting something. He tried to adjust his apparatus as a blind, but invariably they would return, respectively, to midsection and mouth. It was plain to see that the pangs of *mal de mer* were beginning to have their effect.

"You bet those bellhops are some sleepy." I hastened to assure him. "And you ought to see them rubbing their stomachs. You'd think there was static in 'em."

The hand came away from his waitsline with a jerk so strong that it knocked the detector out of adjustment. By the time he had this fixed Snell was ready with another frontal attack.

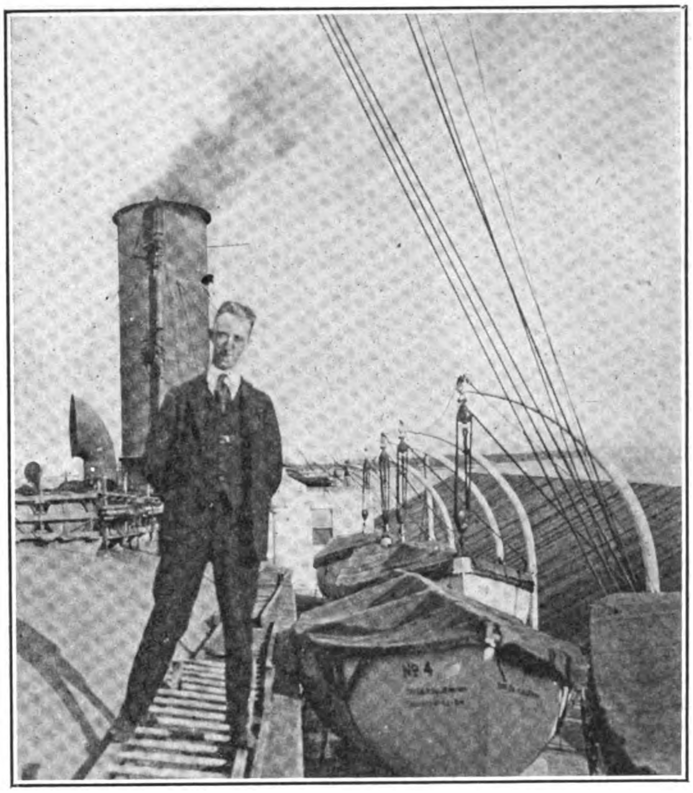
His voice took on a reminiscent strain. "I remember one time I was up in Lake Superior. It was blowin' something awful—just about like this, in fact—and the bellhops on board had been eating all kinds of stuff. They had turned out to see the fair at Houghton and all the candy, peanuts and popcorn in the place came back inside them. Well—would you believe it?—every last one of these fool kids got sicker 'n dogs. And the funny thing about it was the way they got sleepy just before they ran for the rail. They kept gettin' sleepier 'n sleepier, 'n they were all rubbin' their——"

"Wait a minute!" wailed Jones. "Somebody's calling me."

He pretended to listen awhile for signals. Then he announced that he must have been mistaken.

"I guess it was just—just static. This roll kind' a goes to my head. It's not likely that I'm going to get sick but you guys had better go to bed. It's blowing fit to kill outside, and I don't want to be bothered with any sick fellows 'round here."

Snell and I both assured him that we were over our sleepiness. "I wouldn't go to bed for the world now," said Snell. "All this reminds me of that night on Lake Superior. Yep. The swell was just about as bad as this



The author, who engagingly tells why he would rather be a wireless operator than the president of Germany or the Great Mogul of Hindustan

—it's rolling like thunder, do you know it, Henney?" He shifted his gaze. "Well those bellhops had been eating mince pie and drinking pink circus lemonade, and all that sort of stuff you know, and—

"By the way, Jones, feeling sick? That light makes you look kind of pale."

I felt it was up to me to say something. "If you want to turn in for a while old man," I began in sympathetic tones, "Watson and I'll be glad to stay on the job." This offer to stay up for him was very magnanimous, and Snell smiled approval. "Go and stretch out for a while," I added soothingly. "That's the best thing for seasickness. Just go to sleep and we'll have a good time sitting up while you are getting better."

Snell hitched his chair a little closer to the bunk room door, effectively closing the entrance to that haven of security. Jones looked longingly at the white sheet on the lower bunk; and, I thought, rather warily at the white wash bowl in the corner behind Snell's back. But he was game.

"I feel a lot better now. I guess I'm getting over my sleepiness. Strange how long this storm stays on, isn't it?"

We had been out all of three hours; which can be quite a long time from some viewpoints. Jones looked up miserably at the lamp swinging back and forth with the roll of the ship, and then added as if he had just thought of it. "If I get feeling bad, I'll let you fellows stay on duty for me."

Snell's voice took up its monotone. "Well sir, those poor bellhops were about the sickest bunch of fellows I ever saw. They had been eating all kinds of stuff down at the buffet and"—Snell's story always started and ended with the eats—"and the stuff simply wouldn't—. You haven't been eating anything, have you, old man?"

"Only a little popcorn this afternoon," came in a weak voice from the stool. "And I drank some buttermilk at Thompson's just before I left tonight. That ought to be all right, hadn't it?"

I looked at him with an expression of shocked amazement. Snell opened his mouth as tho to say something, and then closed it as if words simply couldn't express his horror. Jones paled.

"You don't mean to say that you put that combination in your stomach!" I gasped. "Acid and starch! Why man alive that's enough to kill you on land, let alone on board ship in a gale like this. Thompson's buttermilk! Did you hear that Watson? That rotten manufactured stuff with the microbes floating around on top with their toes up in the air! It's a good thing he didn't load up like that guy in the buffet, eh Snell? Just think of a nice smelly sardine sandwich and a bottle of ginger ale added to that mess—"

I was interrupted by a despairing groan from the top of the stool.

"Oh Gawd!"

Jones slipped from the stool, made a staggering dive for the door, missed Snell by a half inch, and a few minutes later we heard him plump down on the bunk.

Mal de mer had conquered.

The August Wireless Age Will Contain

an interesting article on the design and construction of buzzer transmitters for transmission at amateur wave lengths. Experimenters having a source of 110 volts D. C. or 500 volts D. C. are enabled, with this apparatus, to transmit over distances up to 100 miles. The transmitter to be described has been used in airplane communication with success. The construction is of marked simplicity.

A special article, on Resonance in the Audio Frequency Circuits of an Amateur's Transmitter, contains information of utmost value to experimenters contemplating the construction of Quenched Gap Transmitters.

Ensign Rodd

He Got Across

Something About Ensign Rodd, First Wireless Operator to Fly Across the Atlantic

TO Ensign Herbert C. Rodd, a former amateur of Cleveland, Ohio, and an ex-Marconi operator who enlisted in the Naval Reserve shortly after the United States entered the war, fell the unique distinction of manipulating the wireless apparatus on America's flying boat NC-4, the first craft to span the Atlantic by the air route. As the nation rejoiced on May 27th that the realization of a dream centuries old had a material basis in fact, universal congratulation was extended by wireless workers to the young man who had successfully maintained communication on the aircraft during its flight across the wide ocean.

That a former amateur should have been selected for this position of great responsibility is an additional fact to establish the importance of extensive development of the experimental field in wireless. Once again it is emphasized how much was contributed to the Navy's success by the civilians called to its ranks in the emergency, and this incident should be viewed as a climax to achievement, setting at rest for all time proposals looking for government ownership sponsored by Naval officials.

General public recognition has been given to the aerodynamic aspects of the great flight and it is looked upon as a gloriously fitting triumph for the United States, a country which produced the Wright brothers, the first to achieve mechanical flight in a heavier-than-air machine; also another American, Glenn Curtiss, first to make the airplane a water as well as an air machine. Little attention has been given, however, to the equally significant fact that the country of Ensign Rodd was the first to develop and encourage amateur wireless in a broad way and place it on a scientific basis. Now that it is generally recognized that the success of the flight was in a large measure due to the perfection of communication arrangements, it is equally fitting that the event be celebrated as a triumph for American wireless men.

As to the particular individual who handled the key: he is a typical American amateur in every respect. His mother, in commenting on his achievement, voiced in a sentence a biography which might be applied to the many thousands who are daily engaged in wireless experimentation. Mrs. Rodd said, "Ever since he was a boy, my son has been experimenting with electrical devices, endeavoring to improve them."

He joined the Marconi service at the opening of the Great Lakes navigation season, seven years ago. His first assignment was on the steamer Eastland, and during 1913 and 1914 he served as senior operator on the Octorara. He was then transferred to the Lakeland, on which vessel he won recognition as an S. O. S. celebrity. His vessel ran on the rocks off the port of Alpena, November 10th, 1914, during a gale and heavy snow storm. Rodd sent out the distress signals and established communication with the Marconi station at Cleveland, from which the wrecking tug Favorite was dispatched to the Lakeland's assistance. The young operator maintained constant communication with the wrecking tug until she arrived, and then joined the crew in lightening her cargo to the end that, with the assistance of the tug and life saving crew, the vessel was safely towed to Port Huron, Ohio.

The following season Rodd became operator at the Marconi station in Detroit, Michigan, remaining there for several months and then accepting a transfer to the yacht Nakomis. He remained on this vessel until the close of navigation in 1916.

In the Spring of 1917 he heeded the call to arms and entered the Naval Reserve as Electrician, First-Class. His first assignment detailed him back to the station at Detroit, and a later transfer brought him to the Marconi station in Cleveland. When a few months had elapsed, he moved on to the Marconi station at Calumet, Michigan, where he took charge of the equipment and received a rating as Chief Petty Officer. His ability had then attracted attention, and he was called to a naval station at Great Lakes, Illinois, where he was placed in the laboratory and assisted in the construction of the ground station and distant control station at this point. He was commissioned an Ensign in the Fall of 1918 and was transferred to Norfolk, Virginia, where he displayed such unusual radio ability that selection fell upon him as radio officer of the NC-4.

At It Again

After two years of painful suspension of activities the wireless amateur is again on the job. Above, a New York Y. M. C. A. enthusiast is making the familiar adjustments inseparably associated with the joy of "listening in"

On the left is A. W. Nelson of Montana longingly cuddling a radio phone transmitter

Press Ill. Svce.

And here, the most familiar of sights—the old aerial going up! The particular amateurs are Barber and Terleph of Richmond Hill, N. Y., but the task engaged in is applicable to ary locality in these broad United States

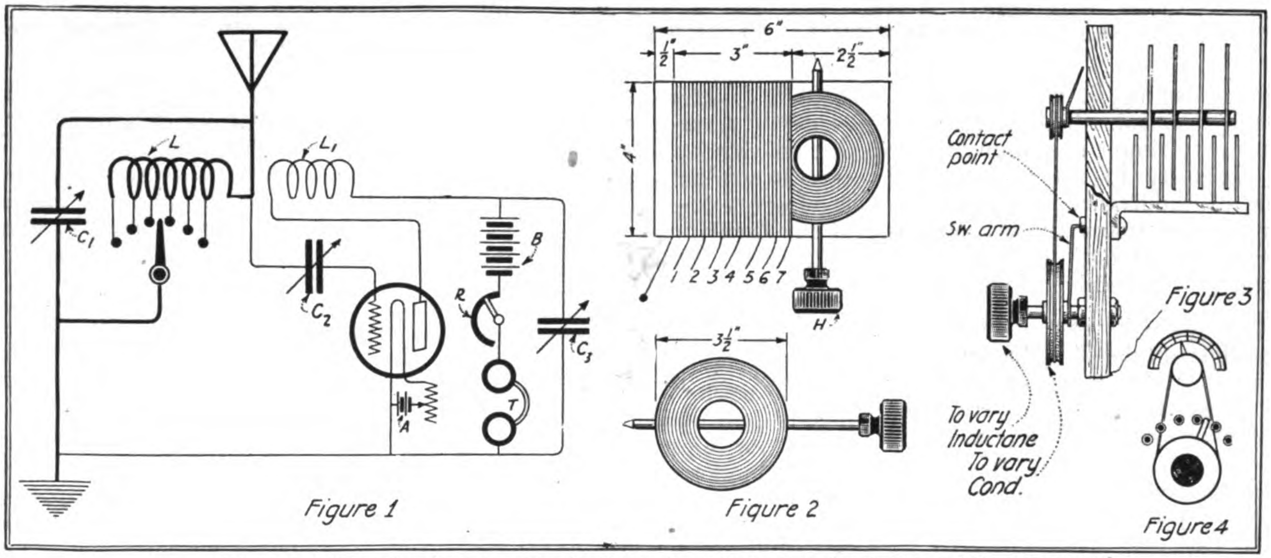
EXPERIMENTERS' WORLD

Views of readers on subjects and specific problems they would like to have discussed in this department will be appreciated by the Editor

Efficient Receiving Apparatus and Experiments with Electrostatic Coupling

By E. T. Jones

THE receiving circuit about to be disclosed is superior to the usual run of circuits presented by various experimenters. One of the principal features is that the valve may be made to oscillate steadily at frequencies corresponding to waves as low as 150 meters. In fact, the circuit functions well at wave lengths between 150 and 3,000 meters, but for still longer waves the more common circuits are preferred.



Drawings showing the elementary circuit, the tuning inductance and end turn switch, respectively

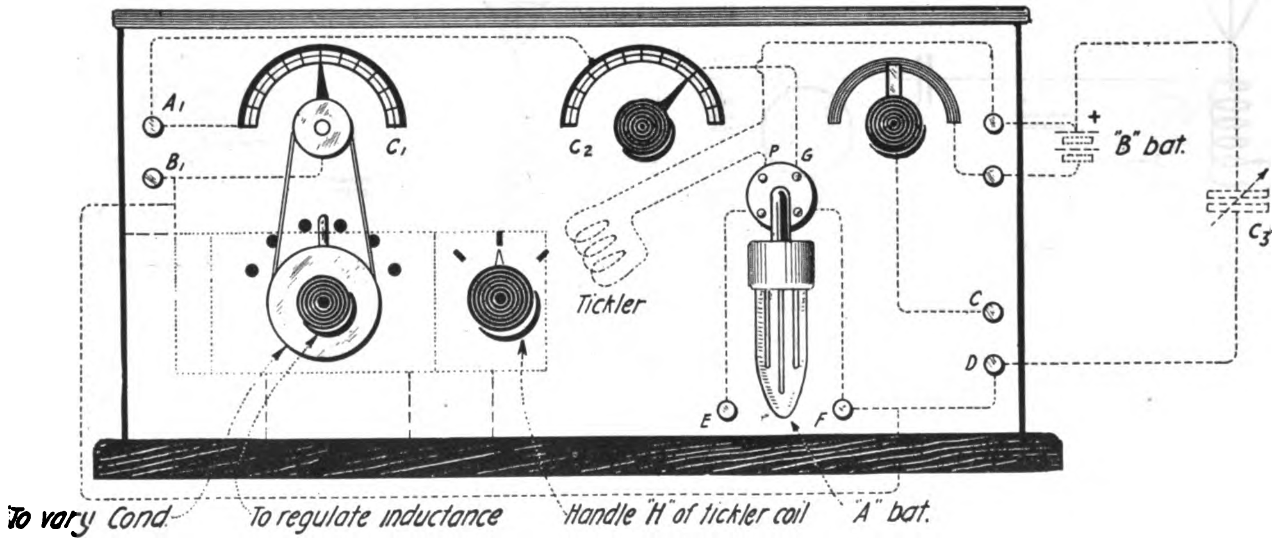


Figure 5—Showing complete apparatus mounted in one cabinet and phantom view of the tuner and its connections

Many of the several hundred circuits shown heretofore have the great disadvantage of introducing too much inductance in the associated circuits to operate on short wave lengths. In the following diagrams this is overcome in a way that improves the overall efficiency.

Figure 1 is an elementary circuit; L, constitutes the tuning inductance, and L-1 the tickler coil. It will be shown later that instead of providing two coils for the tickler, the primary is mounted in the end of the tuning inductance and caused to rotate in much the same manner as the movable coil in a variometer.

C-1 is the usual shunt variable capacity across the tuning inductance L. It is to be noted that no primary inductance is employed, and the losses which would be present in capactive or magnetic coupling are eliminated. In fact it was noticed that approximately twice the strength of signal was obtained when using the connections shown; and quite contrary to the belief that such a circuit would furnish broad tuning, it was found exceptionally critical. This makes the tuning a very simple operation, it only being necessary to cut in a certain amount of inductance and vary the condenser until maximum response is had. A detailed outline of the construction of this receiver follows:

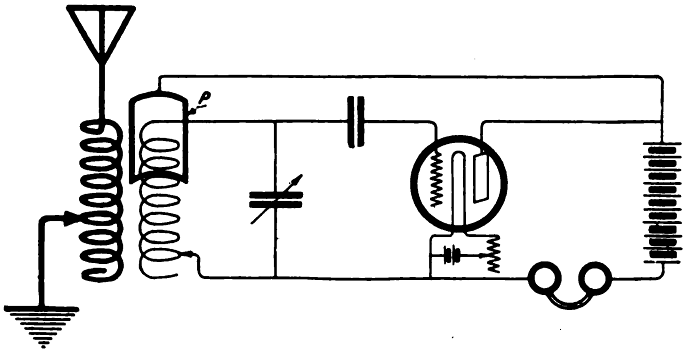


Figure 6—Showing plate circuit electrostatically coupled to the secondary

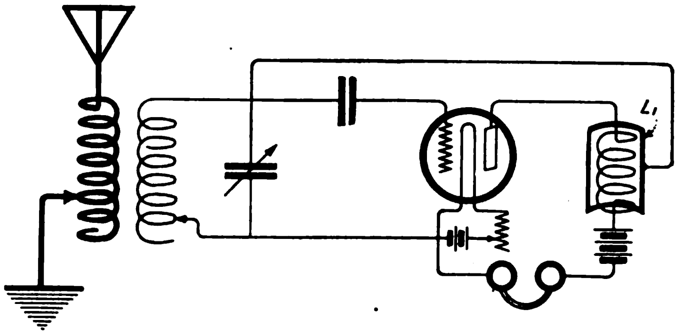


Figure 8—A modified method of obtaining electrostatic regenerative coupling

THE TUNING INDUCTANCE

A cardboard tube 4" in diameter and 6" long has a 3" winding of one layer of No. 28 S.C.C. wire. Taps are taken off as shown by the numbers in figure 2, ¼"-¼"-½"-½"-½"-½"-½", which makes a total winding of 3".

THE TICKLER

The tickler primary is wound on a frame 3½" in diameter pivoted as shown and placed in inductive relation with the secondary inductance, the degree being controlled by moving the handle H. It is wound with the same size wire—No. 28 S.C.C.—for a space of ½". A very good form can be made of pasteboard tubing instead of the wooden form.

Any of the various forms of end turn switches can be provided. The design was purposely left out here for the sake of simplicity. All that is necessary after the completion of this inductance is to have a variable condenser mounted in the same cabinet as shown; and in order to simplify the tuning, the arrangement shown below is recommended.

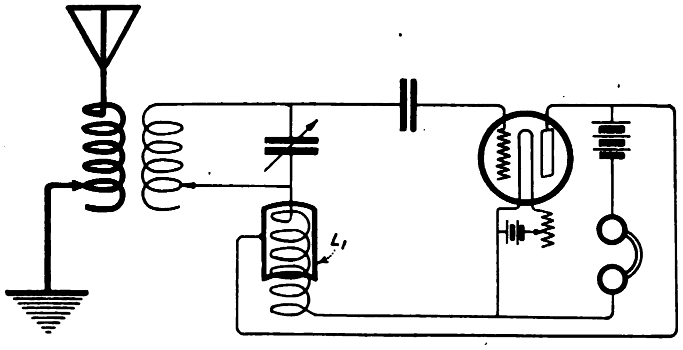


Figure 7—Another method of coupling electrostatically the plate to the secondary-grid circuit

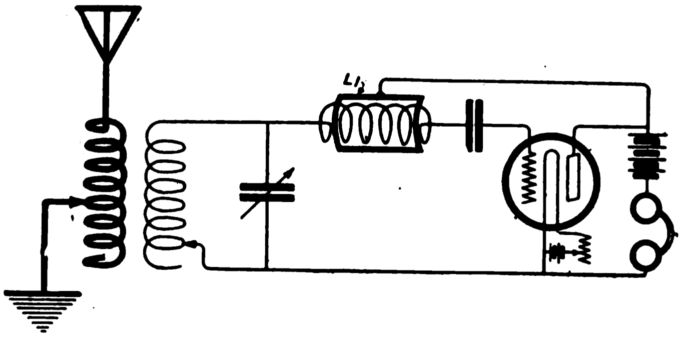


Figure 9—Another form of coupling showing the coupling plate connected to the plate of the audion

This arrangement consists principally of having the condenser geared by pulleys to the handle of the inductance switch as shown in figures 3 and 4. The pulley mounted on the latter is made to move easily upon the shaft of said switch; this makes it unnecessary to use both hands when tuning, leaving one hand free for manipulation of the oscillating circuits.

It is best to mount the above apparatus in one panel separate from the oscillating circuits because if it is desired to change over from the short wave receiver to a long wave set, it can be accomplished by the use of a double pole double throw switch.

But for those desiring to put the complete apparatus in one cabinet the following details regarding the apparatus as shown mounted in the drawing of figure 5 will be of value. As therein indicated, the condenser is mounted at the top of the left hand side of the panel and just under it, the inductance coil, the aerial and ground connections being made to the binding posts A-1 and B-1. The tickler, previously described, is mounted so that its handle H protrudes outside of the panel.

The right hand side of the cabinet shows the audion adapter, the B battery resistance and the telephones, which are to be connected at C and D. The position of the grid condenser is also shown.

Figure 5 shows a phantom view of the tuner and its connections. Condenser C-1 is shunted across the tuning inductance and condenser C-2 is connected in series with the grid of the audion and the aerial connection A-1. R is the high resistance "B" battery regulator and C, D are the telephone terminals. The A battery or filament battery is connected to the terminals marked E, F. No dimensions are given owing to the fact that the condenser containers vary in size. Any experimenter interested in long distance amateur short wave reception cannot fail to investigate the merits of this circuit, for in addition to giving loud signals, it affords a notable degree of selectivity.

With this type of circuit one is not restricted to the use of very small antennae. By inserting a variable condenser in series with the antenna, if too large for the reception of 200 meter wave lengths, the strength of the signal is not decreased and in some cases it was found to improve the strength, probably due to the fact that the condenser tended to alter the voltage distribution so that a very high E.M.F. was impressed upon the grid of the tube.

Exceptional results were had with an antenna 60 feet long of four wires, spaced 4 feet apart. One supporting mast was 60 feet high, the other 25 feet high.

SOME EXPERIMENTS WITH ELECTROSTATIC REGENERATIVE COUPLING

A method of coupling valve circuits electrostatically for various purposes has been described in a former patent by Bucher. I have found certain forms of his method of capacitive coupling to-

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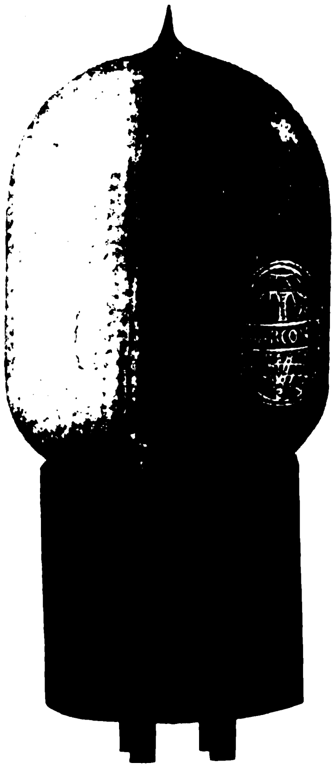

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Agreements recently effected have made vacuum tubes available for experimental use. The Marconi V. T. is the only vacuum tube, or audion, which may be sold to amateurs, laboratories, schools of instruction and experimenters.

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be very practical in oscillating tube circuits.

Figure 6 shows the plate circuit electrostatically coupled to the secondary. This is accomplished by bringing the metallic semi-circular plate P in proximity to the end of the secondary winding which protrudes out of the primary. Very good and valuable results were secured with this arrangement. The plate P has a critical position in respect to its distance from the secondary windings for each change of wave length, being closer for short waves and farther away for long waves. The plate P must be fitted with a long insulated handle because, due to the coupling between the body and the coil, the presence of the body has a marked effect on the oscillating period of the circuits.

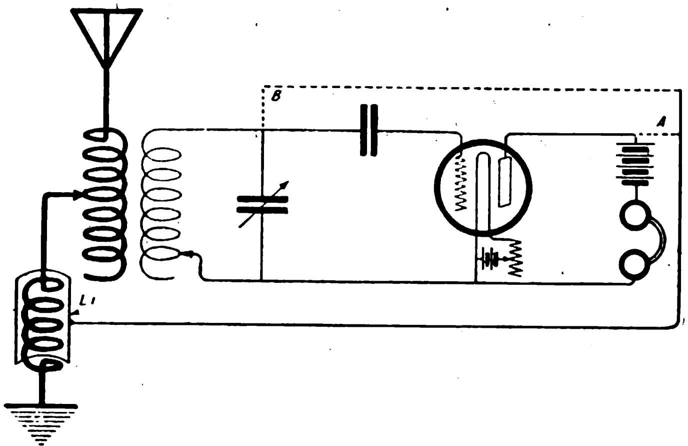

Figure 10—Electrostatic coupling obtained by connecting the coil L-1 in the primary ground lead and the coupling plate to plate circuit of the audion. Very efficient for long waves

Figure 7 shows another method of coupling electrostatically the plate to the secondary-grid circuit. Here the small inductance L-1 is inserted as shown and the plate P brought in close relation thereto.

Figure 8 indicates a modified method of obtaining electrostatic regenerative coupling. The plate P is connected to one side of the grid condenser and the small coil L-1 is connected in the plate circuit as shown. The coupling is varied as before by increasing or decreasing the distance between the plate and the coil L-1. This circuit gives as good results as the two aforementioned. The circuit of figure 9 is particularly useful for short waves.

Figure 10 shows still another form of electrostatic coupling. Although this circuit failed to function on short waves, it gave very good results on the longer waves. The coil L-1 is connected in the primary ground lead, and the plate to the plate circuit of the audion. On short waves such as 600 meters the plate had no effect, but after getting up to 5,500 and 8,000 meters, it required a very critical adjustment. As shown by the dotted lines two connections were tried, but the best results were obtained when it was connected to A.

Figure 9 shows another method which gave very good results on short wave lengths in the region of 200 meters and is substantially the same as figure 7. The plate P was connected to the plate of the audion and electrostatically coupled to the inductance L-1 connected in the grid circuit as shown.

This method of electrostatic coupling certainly has a wide range of applications in connection with audion regenerative circuits, and it is well worth one's time to dig in and see what is in store for the wireless world at large.

Suggestion for Prize Contest AUGUST Wireless Age

We will pay the usual prizes of $10, $5 and $3, in addition to our regular space rates, to the three contributors who send us the best manuscripts on the following subject:

"What do you consider to be the best circuit for undamped wave reception at wave lengths from 4,000 to 18,000 meters and what should be the dimensions of all tuning coils with the average antenna?"

Vacuum Tube Construction

H. J. NOLTE of Schenectady, N. Y., has shown the design of the internal structure of a three electrode vacuum tube as indicated in the drawings, figures 1, 2, 3 and 4. Figure 1 is a view of the completed pliotron; figure 2 is a view of the pliotron with the bulb and the anode broken away; figure 3 is a view of the anode and figure 4 a sketch of a metal sheet from which the anode is constructed and which shows how the supporting strips are cut away.

The completed pliotron comprises an evacuated bulb 1 within which are located the cathode 2 in the form of a coil filament which is preferably of tungsten, a grid 3 in the form of a coil wire surrounding the cathode and a cylindrical anode 4 surrounding the grid.

Leading-in conductors 5 which are sealed through the stem 6 supply current to the cathode and leading-in conductors 7 which are also sealed to the stem 6 supply current to the grid. The anode 4 is supported by two arms 8 and 9 both of which are sealed into the stem 6. Arm 8 extends through stem 6 and serves to carry the anode current.

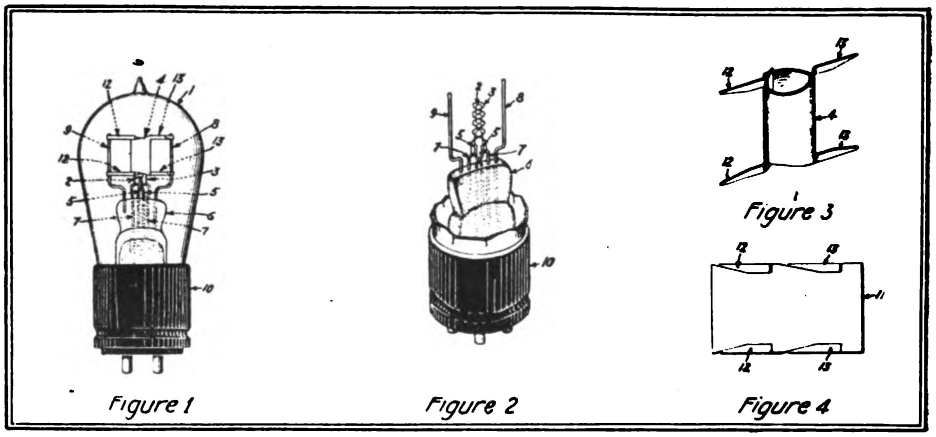

Figure 1 Figure 2 Figure 3 Figure 4

Drawings showing the complete pliotron; view of pliotron with bulb and anode removed and finally the anode complete and method of construction

The anode is constructed of a rectangular sheet of metal as shown in figure 4. From each side of this sheet, strips of metal 12 and 13 are partly cut away in the manner indicated. The sheet is then bent into cylindrical form and the strips 12 and 13 are bent away from the cylinder so as to extend in diametrically opposite directions therefrom as indicated in figure 3. The ends of the strips are then wound around the supporting arm 8 and 9 as shown in figure 1 and welded thereto.

Controlling the "B" Battery of a Vacuum Tube

The connections shown in the accompanying drawing for "easing up" the "B" battery control of vacuum tubes may be of interest to amateurs who are troubled with critical potentiometer adjustments. A 400 ohm potentiometer shunted across the last two or three cells gives a very fine control of the local E.M.F. It has the further advantage that it does not run down the entire B battery which would be the case if a potentiometer of such low resistance were shunted across all the cells. It will be noticed in the upper part of the drawing that an end cell control of the plate voltage is provided, a three point switch being connected to the two end cells to permit them being cut in or out.

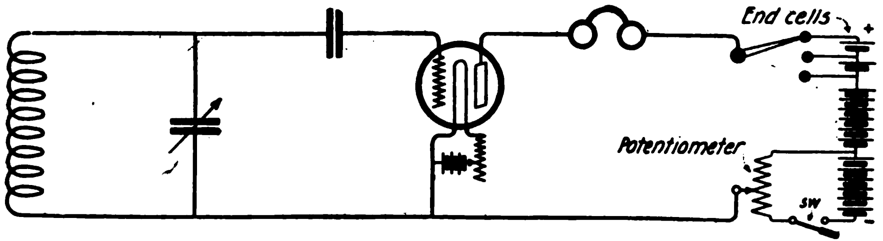

Diagram of connections for controlling the "B" battery of a Vacuum Tube

I have used this diagram of connections with great success.

Louis Funke—*New Jersey.*

Contest Winners for July

The May Wireless Age subject for discussion was: "To what extent do you believe that wireless telephony will take the place of wireless telegraphy in amateur communications?" The usual prizes have been awarded to the writers of the following articles.

First Prize—Will It Be "Hello" or Telegraphic Buzzes

We are asked to what extent in the future, the wireless telephone will take the place of the wireless telegraph. This question causes us to regret our lack of the gift of prophecy, for here indeed is a job for a wiseacre. The first thought that occurs to one in the consideration of this question is that everybody can talk, but that comparatively few can send and receive wireless messages; therefore, we are likely to conclude that the amateur will be in haste to abandon the crackling telegraph for the still, small voice of the radiophone. But there are considerations that will make many of us pause. A very little money will install a simple wireless telegraph set. If one merely wishes to receive, almost any piece of wire sticking up in the air a few feet will serve as an aerial. One can easily make a tuning coil, a fixed condenser and a detector stand. A pair of telephones will cost about five dollars, and a bit of galena a few cents. With this equipment one can hear stations hundreds of miles distant, perhaps a thousand.

Of course even the smallest and simplest sending outfit costs much more, but almost any young man of enterprise, industry and ingenuity is able to install a complete set if he wishes to do so. On the other hand, the radiophone is too costly for the average amateur. I have scarcely any idea what a transmitter, good for a hundred miles, would cost, but I do recall that I once saw a transmitter offered for $375, but it would transmit only seven miles. So, looking at it from a pecuniary standpoint, it does not seem probable that the amateur as we have known him in the past will plunge very deeply into wireless telephony.

Then it seems to me that to those who have wireless telegraph outfits, the wireless telephone would become a commonplace thing. As before remarked, anybody can talk, but to be an expert telegraphist requires severe, persistent endeavor; and the things that are acquired only by labor and sacrifice are the things that are most valuable to us—things that cannot be handed over the counter for so much money.

But cost is doubtless the chief factor in the question. Leaving cost out of consideration, it is almost idle to speculate. We know that wire telephony has elbowed wire telegraphy to one side to a great extent in the last few years. Perhaps the amateur will follow the line of least resistance, take something that requires but little training and go in for the wireless

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telephone as far as the state of his treasury will permit; but it is to be feared that this condition will restrain the enthusiasm of many of us. Of course the high cost of wireless telephony applies only to transmission. Any receiving set equipped with an efficient detector will reproduce the human voice. It is possible that when wireless telephone stations come to be established in all large towns (as they surely will), thousands of amateurs who know nothing of telegraphy will install receiving sets in order to enjoy the wonder of taking from the regions of space an energy that will reproduce words spoken hundreds of miles away. I well remember the surprise, almost terror, with which I suddenly heard a voice coming out of the depths of space as I sat with the telephones on my head one night over two years ago. The mysterious and unknown speaker ended by singing "The Swanee River."

So, to sum the matter up, I should say that the cost will prevent the average amateur having a wireless telephone transmitter, but that when strong transmitting stations are established in the principal places, receiving stations will be numerous. But I hope and predict that the amateurs as a body will not abandon that branch of wireless that requires practice and skill, and whose rewards are only for those who are willing to pay for them by earnest endeavor.

The development of a cheap wireless telephone transmitter may upset my prognostications; but that is just what we amateurs are waiting for—an inexpensive radio telephone set.

S. F. McCartney—*Pennsylvania.*

Second Prize—Radio Telephony as Regards the Amateur

I AM somewhat "on the fence" in offering a comparison of the ultimate relative value of the wireless telephone and telegraph in amateur communication. Comparing them from the viewpoint of present day progress, I stand in favor of the wireless telegraph, but I see that in the future, wireless telephony may become a very serious competitor of the wireless telegraph. Although the two systems of signaling have points in common, the matter of expense, manipulation, etc., in the two types of apparatus is vastly different.

To my mind, the up-to-date and progressive amateur will be the first to experiment with radio telephony, but it is certain that for a number of years radio telephony will not replace, even partially, radio telegraphy. It must be admitted that radio telephony has advanced rapidly during the war, but the operating characteristics of the wireless telephone have not changed sufficiently to afford it a better position in the eye of the amateur. The wireless telephone necessitates the use of complicated and intricate circuits, and expensive apparatus that is beyond the resources of amateurs of limited means. In fact, one of the first things that must be done to create genuine enthusiasm among amateur experimenters is the production of a cheap wireless telephone set that he may construct or purchase. It is a well known fact that all amateurs are "dabblers" and like to construct their own apparatus. The experimenter can construct all of the apparatus employed in radio telegraphy because of its great simplicity, but this cannot be said of the apparatus used in wireless telephony.

Not only is the construction of the wireless telegraph apparatus less expensive, but the actual building of the apparatus gives experimenters an insight into the fundamental principles of radio and constructional details that tends to make them better informed men. The radio telephone includes so much apparatus that the amateur cannot construct, that he is not likely to attempt to build a set. If radio telephony is to replace, even partially, radio telegraphy in the amateur field, more simple circuits and less expensive instruments must be provided.

There is another point decidedly in favor of the radio telegraph. Surely as long as the amateur can signal 2,000 miles by radio telegraphy, he will never be content to telephone 50 to 100 miles, for after all, it is the range of the radio telegraph that gives the amateur such genuine amusement. If the telephone could be worked as far as the telegraph, my arguments would be just the reverse.

If, in the future, some one provides a wireless telephone transmitter that will permit experimenters to talk several hundred miles at the wave length of 200 meters, then it is apt to prove a serious competitor to the wireless telegraph, but it is very doubtful whether such a set will be produced.

The amateur, having plenty of funds, will undoubtedly construct a short range vacuum tube wireless telephone set to be operated alongside his standard transmitting set, but it is to be doubted whether he would be satisfied with a wireless telephone set alone. I firmly believe that the wireless telegraph set will stay on the "top of the heap" for many years to come.

Arlyn Rosander—*Michigan.*

Third Prize—This Experimenter Favors the Wireless Telephone

DURING the war vacuum tube wireless telephone sets were perfected by the allied governments to the point where it became possible to talk a hundred miles or so with an input of less than one kilowatt. Scores of amateurs are preparing to experiment with this new form of communication as soon as permission is given to use their transmitting stations. It is my opinion that the wireless telephone has been improved to such an extent that it may supersede the wireless telegraph in amateur stations.

The radiophone has many advantages over the telegraph and a few disadvantages. Among the advantages, the most important is the fact that one does not need to learn the telegraph code.

The second advantage applies only to amateur transmitters using the rotary or straight spark gaps operated in the open air. Here the wireless telephone, with its absence of the crashing discharge, is much to be preferred to the old type of transmitter, where a blinding flash occurs every time the key is pressed. Due to the comparatively low potentials used in wireless telephony, breakdowns of insulation in the aerial or apparatus are largely eliminated. For the same reason very little leakage from the aerial to the ground will occur when the wireless telephone is used, rendering it less liable to losses of energy.

Another advantage of the vacuum tube radio telephone set is that by inserting a key in the control circuits, it is possible to transmit telegraphic signals as well as the voice. The telegraph signals will carry a greater distance than the voice, making it possible to use the telegraph when operation over long distance is necessary and the voice when considerable correspondence is to be carried on in a short time.

Although telegraphic signals from such sets transmitted by undamped waves can be received only on an oscillating audion circuit, the voice may be heard on any standard wireless receiving set, making it unnecessary for the younger experimenters to go to the expense of building a regenerative vacuum tube receiver.

The only disadvantages of the wireless telephone over the telegraph are the expense, the short range and the precision of adjustment necessary if the telephone is to operate successfully. However, at the rate improvements are being made in the apparatus used in wireless telephony, it will be but a short time until instruments are placed on the market that will be entirely suitable for amateur radiophone stations. A precise adjustment of each complement of a wireless telephone transmitter is required if the set is to be successful. By the help of good books on the subject, any amateur can soon learn to maintain the apparatus in correct adjustment.

We will now consider some of the former uses of wireless telegraphy among amateurs. Before the war, amateurs operated, successfully, a line of radio relay stations, extending in all directions over the country. Hundreds of messages were transmitted every night. Some of these stations in order to get a message to the next station along the line, were obliged to span distances of several hundred miles, especially in the West, where, at some points, suitable amateur stations were few and far between. For this reason, constant and reliable service was not possible at all times, because of atmospherics and QRM.

Several leading amateurs advocated shorter relays, as a solution of the relay problem, but the war stopped all experimenting, so that lines having shorter relays have not yet been tried out. If, in the future, shorter relays become a reality, I believe the wireless telephone will offer a reliable and speedy means of relaying messages. Although the speed of transmission is reduced by having to pass through a greater number of stations, the telephone will make up for that loss, because many more words can be spoken in a given time, over the wireless telephone, than can be transmitted over the wireless telegraph.

Some owners of private stations use their sets to chat with near-by friends, for the mere novelty of sending signals through the air. This class of experimenters will be apt to adopt the wireless telephone more than any because the feat of actually talking through the air will appeal to them as a new toy.

There was some fear for a time that amateur wireless was done for when the President issued the executive order closing all private stations, for the period of the war, and again when anti-amateur legislation was introduced; but instead of discouraging the amateur's efforts, these obstacles seem to have created a new interest in the science, which has been augmented by the numerous inventions and improvements made during the war.

We may conclude that the wireless telephone is capable of replacing the telegraph for nearly all amateur purposes, the exception being stations located at great distance from one another.

J. E. LAW, JR.—*West Virginia.*

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A Letter of Appreciation

I WISH to thank you for accepting me as a member of the Association. I also wish to congratulate the N. W. A. on the way they handled the Alexander bill. You may be sure that thousands of amateurs throughout the old U. S. A. are grateful to the N. W. A. for the work accomplished.

I feel that the amateur would have been a thing of the past if the N. W. A. had not stepped up and opened the eyes of Congress to the fact that amateurs are not kids at play, but that they constitute a full-sized man's organization.

I would also like to see the suggestions go through that 9YI suggested in the March bulletin; that is, the matter of State Organization. In an organization of this kind each state could have a get-together meeting once a year which would be of inestimable value. Other state associations have been formed; what is to prevent us doing the same thing?

VICTOR H. CARRUTHERS, *Grace, Idaho.*

A Comparison of the Isolated Instrument and the Panel Transmitter

THE argument whether the panel type or isolated instrument type of wireless transmitter is best suited for the amateur, to my mind, depends upon the use to which they are to be put. One type of amateur uses his set simply for social purposes, and after it is once in operation, it is very seldom altered, but is used constantly to communicate with friends. This type of experimenter rarely carries on extensive experiments and knows little of the theoretical principles of his apparatus. The panel type of transmitter, in the opinion of the writer, is best suited for this amateur since it is compact, less liable to get out of order, is portable and presents a very neat appearance. On the other hand, the man who can truly be called a radio experimenter studies the theory of the different parts of the set, makes changes constantly to correspond with the advancement of the radio art, and also experiments to determine the characteristics of the several instruments used.

Intensive experimenting is not possible unless each instrument is isolated, this being true of all phases of scientific research, whether it be radio, electrical, chemical.

It appears to the writer that a panel type of transmitter would not appeal to the amateur with a scientific turn of mind. Even small changes must be made to satisfy his curiosity. Such experimenters represent the type of man that proved so efficient in the military service during the war.

The Government, at the present time, is utilizing the panel type of transmitter exclusively. Complete sets, up to 1 kw., are being used as one unit, even the motor generator being contained therein. This design has been adopted because it provides for ease of manipulation, quick installation and portability.

The progressive amateur finds that the vacuum tube is replacing the familiar spark gap transmitter as a source of radio frequency currents and its development is most assuredly in its infancy. It would be impracticable to construct a panel transmitter of this type because radical improvements are constantly being made. It is possible that, in a few years, the spark transmitter will be obsolete.

In conclusion, therefore, I believe that, of the two respective types of wireless transmitting sets for amateur use, the isolated instrument type is preferable, first, because the experimental type of wireless enthusiast is decidedly in the majority, and second, because it advances the knowledge of amateurs, and third, it eventually causes less trouble to our Government in the enforcement of the wireless law.

L. R. JEWETT—*Massachusetts.*

Improved Circuit for the Stern's Tube Transmitter and Receiver

By Morton W. Sterns

THE operation of the set I described in the June issue of THE WIRELESS AGE may be considerably improved upon by adding the features shown in the accompanying drawing.

In the first place, the carbon potentiometer now connected in the plate circuit, makes the impedance of the output circuit higher, thereby giving increased efficiency when receiving. It must, however, be shunted out of the circuit when transmitting. The resistance is a 20,000 ohm carbon or graphite potentiometer such as may now be obtained to control the voltage of the "B" battery.

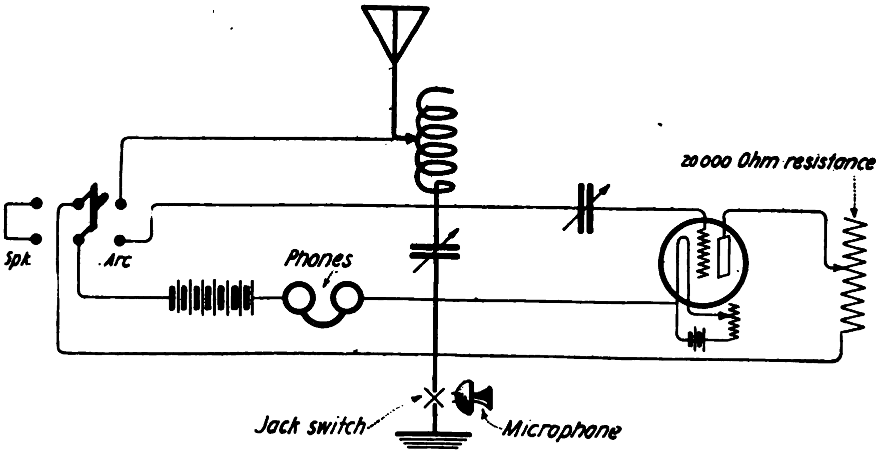

Diagram showing added features in the Stern's tube transmitter and receiver

I have added also, a double pole double throw change-over switch to change from "arc" to "spark" reception and a telephone jack for connecting the microphone transmitter in series with the ground lead.

It is, of course, understood that the two pole switch must be thrown to the "arc" position when it is desired to transmit, so that the bulb will oscillate. It will repay the effort to add these appliances.

Government Control

GOVERNMENT control of radio communication, placed in the hands of the navy department, appears to be a dismal failure when compared to the class of service rendered by private concerns prior to the war, when radio communication was a "free for all" service.

The causes for this are numerous. In the first place, naval work is, in the main, carried on by inexperiened, incompetent men, who have had little or no practical experiene in the handling of commercial radio traffic. Another reason is that the stations on shore which formerly handled only commercial business, and were kept working to their very limit with that, now have to handle naval work and matters of tactics as well as commercial traffic. I have seen traffic suspended for hours at a time—have heard as many as seven different ships after the operator at Miami station at one time, trying for hours to raise him. This has happened not once, but numerous times. Where was he? When this station was under the control of the Marconi Company the matter would have to be explained in a very satisfactory manner. Now it is different; it seems to get by without any trouble.

At the port of New York things are very confusing. There are three different stations using the same call letters—NAH—which is the cause of considerable difficulty to some ships. To illustrate: I have heard messages sent in to NAH, one station coming back with an O. K., while one of the other NAH's wanted a part of the message repeated. Sometimes one NAH will say "K" and another one will say QRT; if you answer one you get logged for unnecessary interference when told to QRT; and if you don't answer, the other station logs you for inattention. So what are you going to do?

The majority—I don't say all, but a surprisingly large number—of the naval radio men are very poor operators. They, by the way, are the only naval men aboard the merchant marine vessels, all the rest of the crew being civilians with the exception of half a dozen naval cadets who are learning navigation with a view of entering Pelham Bay. It is these men who cause unceasing tie-ups in traffic. One ship in particular, a well known passenger vessel, has an operator (or operators) on board of her whose maximum speed of reception seems to be between twelve and fifteen words a minute, providing the air

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is clear of static and interference. If there is any interference at all, this speed materially drops and the ship station is hopelessly lost. I have exchanged traffic with this vessel when signals were readable with the motor generator running, and if messages were sent to him at a speed greater than fifteen words a minute he could not copy them.

I have interviewed a number of naval operators on different merchant ships at various ports in the United States and in other countries, and they all seem to be of the same general opinion: That naval monopoly of radio is a dismal failure, due, for the most part, to the class of operators employed. They will tell some such story as this, when asked their opinion: "Before I joined the outfit I was so and so, making twice as much in a week as I can make here in a month. I joined up for the duration of the war, and now that the war is over, I am anxious to get back to my old job. They are discharging men from practically every other branch of naval service, and I think it is unfair to you and to us to keep us here where a civilian who makes this work his life's vocation would do much better. We take no interest in our work, we do it because it has to be done, we are only in hopes that such a kick will go in to the navy department regarding our service that we will be let go."

One of the naval operators on a passenger ship with whom I spoke said: "Do you suppose we keep a steady watch here like you fellows do? We do not. We work just about as we please, and as for messages, we don't give a hang whether they get off or not."

Now if that attitude was ever displayed by an operator in civilian service he would last with a private concern only long enough to be relieved by a man who *did* care. It is obvious that a man who is compelled to do a certain work against his liking will not do as good nor as efficient work as one who does that kind of work because he likes it and takes an interest in it. A man in a private concern who could not prove himself efficient would not last very long. I am certain that the navy's reputation for high efficiency was *not* established by the radio branch of the service.

The instruments that the naval operators have to work with are examples of the latest advancement in the art of radio communication and in themselves are works of art. But—put a man at those same instruments who takes pleasure and an interest in the successful working of them and he will get a great deal more efficient work from them than a man who "doesn't care."

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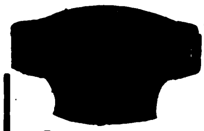

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One thing that the navy department is doing which is very unjust and entirely uncalled for, is the replacing of civilian radio operators on merchant marine vessels by naval operators. For instance, during the war, on some of the ships crossing the Atlantic, we were allowed to remain on. These in almost every case were *unarmed* ships. As soon as the ships were *armed* we were put off and navy men put aboard. Now on English, French and Italian ships, even transports, civilian operators were employed throughout the war. On American ships, the civilian radio men were ruthlessly "dumped." Even under the present conditions of peace, civilians are being replaced by naval radio men!

The loyalty of civilian operators during the war was unquestioned. Yet on American ships they were replaced on their jobs by an inferior grade of inexperienced and incompetent naval operators. We were immediately deprived of our means of livelihood. many of us, due to various reasons, could not join the naval service, even if we had been so inclined. This was very unfair treatment on the part of the navy department. It would not have looked so bad if the entire ship's crews had been naval men; but when every man from the master down to the coal passers were civilians, to have civilian radio men removed and naval men put on was rather a hard pill for us to swallow. On no other Allied ships was this done.

Navy radio men are as much out of place on a civilian merchant marine vessel as civilian operators would be if placed on a naval man of war. We are in hopes that in the near future naval operators will be removed from the merchant marine service and the ships turned over to civilian operators again as in the days before the war. Then, and *only* then, will satisfactory service be given, because the service will once more be conducted by competent men.

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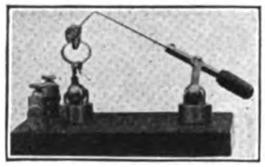

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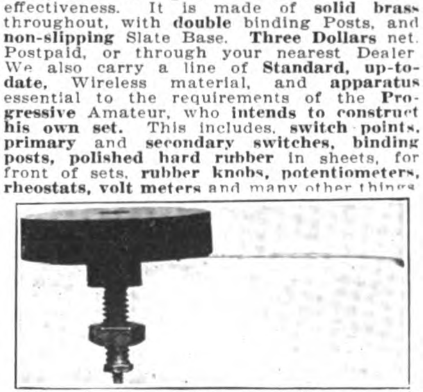

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The use of a variometer in the antenna circuit is not strictly essential but it aids one in obtaining fine tuning in apparatus when the inductance is varied by taps instead of by a "tens" and a "units" switch, such as is employed with modern receiving tuners.

Regarding your last query: You will find that the Marconi V. T. oscillation detector connected up in the receiving circuit shown in a leaflet which accompanies each order will double or triple your present receiving range.

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A. R., Scottville, Mich.:

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Replying to your last query: We do not believe that daily newspapers are in the habit of divulging the contents of radiograms unless they receive permission for so doing. The press matter sent out by Arlington, nightly, may be used freely by any one, but the ordinary radiograms cannot be produced without permission from the sender.

* * *

J. D. M., Springfield, Mass.:

The wave length of the radiated wave in wireless telegraphy is the actual physical distance between two successive points in the wave motion where the stress is in the same direction and of the same amplitude.

The length of the radiated wave bears the following relation to the inductance and capacity of the antenna circuit. Letting the Greek letter Lambda λ = wave length, L_1 = the inductance of the loading coil at the base of the antenna and $\frac{L_0}{3}$ = inductance of the antenna for alternating current and C_0 its capacity, the following formula obtains:

$$\lambda = 59.6 \sqrt{(L_1 + \frac{L_0}{3})\, C_0}$$

Here L_0 is the inductance of the antenna for uniform curve distribution and C_0 its capacity for uniform current distribution. $\frac{L_0}{3}$ and C_0 may be taken as the inductance and capacity of the antenna for radio frequencies

The wave length of a simple vertical wire grounded at one end is four times its natural length. Thus an antenna of 100 meters in length will radiate a wave of 400 meters.

* * *

R. D. W., Plainfield, N. J.:

We do not know the nature of the crystals sold under the name of Lenzite and Radiocite.

Regarding your experiments with cerusite: Genuine cerusite will not act as an oscillation detector in radio. What formerly was assumed to be cerusite was nothing more than a grade of galena of a different crystal formation than that ordinarily used by experimenters.

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* ◆ *

W. G., New York City:

Note the reply to R. D. W. above. The cerusite crystals you sent to us are not suitable for detection of radio signals.

The radiophone transmitter set shown in the March issue will transmit 10 or 15 miles, the actual range depending upon the type of receiving apparatus employed. We are unable to state why your audiotron detector does not function properly. Perhaps there are weak cells in the B battery, or it may be that the secondary winding of your receiving tuner has insufficient inductance to impress the high E. M. F. on the grid circuit, requisite to make the vacuum tube function properly.

* * *

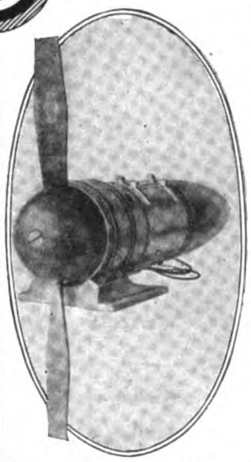
W. L. D., New York City:

The methods of connecting up the vacuum tube as a transmitter or receiver are numerous. We urge that you try all of the circuits heretofore published and decide for yourself which is the most applicable to your particular work. The text book "Vacuum Tubes in Wireless Communication" has descriptions of all the circuits that have been proposed or used.

The diagram of figure 48 on page 80 of that text book should satisfy your requirements, although if you employ a modern tube which is highly exhausted, you should connect a two megohm grid leak from the grid to the filament of each valve. The first tube in that diagram is connected for radio frequency regenerative amplification and one stage audio frequency amplification is provided for the plate circuit. In the newly revised edition of "Vacuum Tubes" you will find on page 180 in the diagram figure 133, the fundamental circuits of a vacuum tube radio telephone set that is applicable to most any type of bulb suitable for the generation of radio frequencies. The coil L-6 in that diagram has inductance from 10 to 13 millihenries, L-5 may have an inductance of ½ millihenry or so. The series condenser in the plate circuit may have a capacity of 1/10 mfd. The telephone transformer P-2, S-2 may be of the ordinary iron-core type. The filaments of the oscillator and modulator bulbs may be connected to the same source.

Wireless telephone communication may be carried on over distances of 100 miles with antenna current of 2 amperes provided at least a three-stage vacuum tube amplifier is used at the receiving station.

Figure 125 of "Vacuum Tubes in Wireless Communication" shows the diagram of a resistance coupled three-tube amplifier which is suitable for cascade radio or audio frequency amplification. The diagram shows a circuit for regenerative radio amplification and beat reception, but perhaps better results will be obtained by using a single bulb for generating radio frequency currents and placing it in inductive relation to some part of the antenna circuit.



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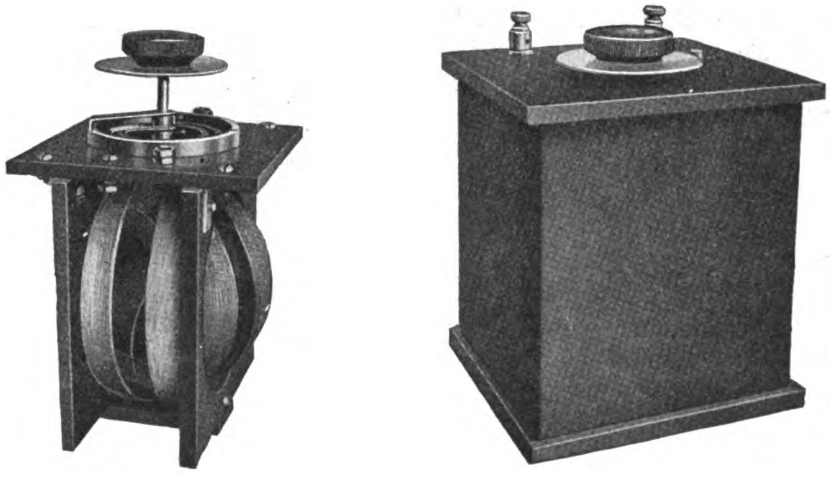

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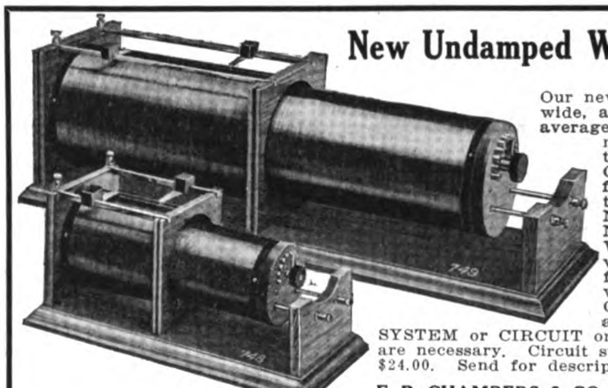

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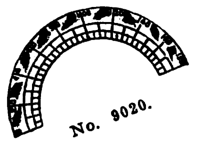

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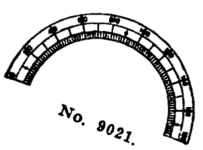

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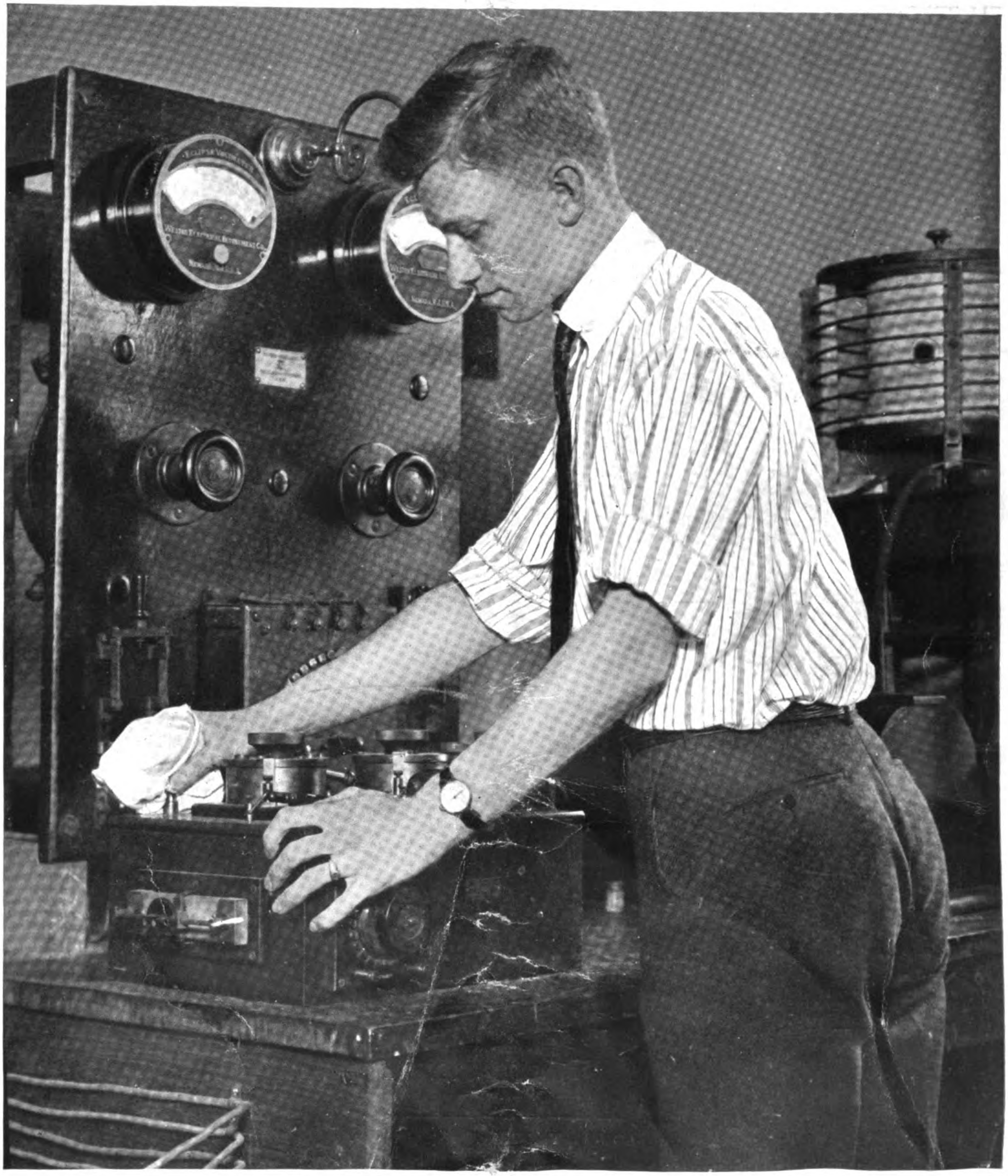

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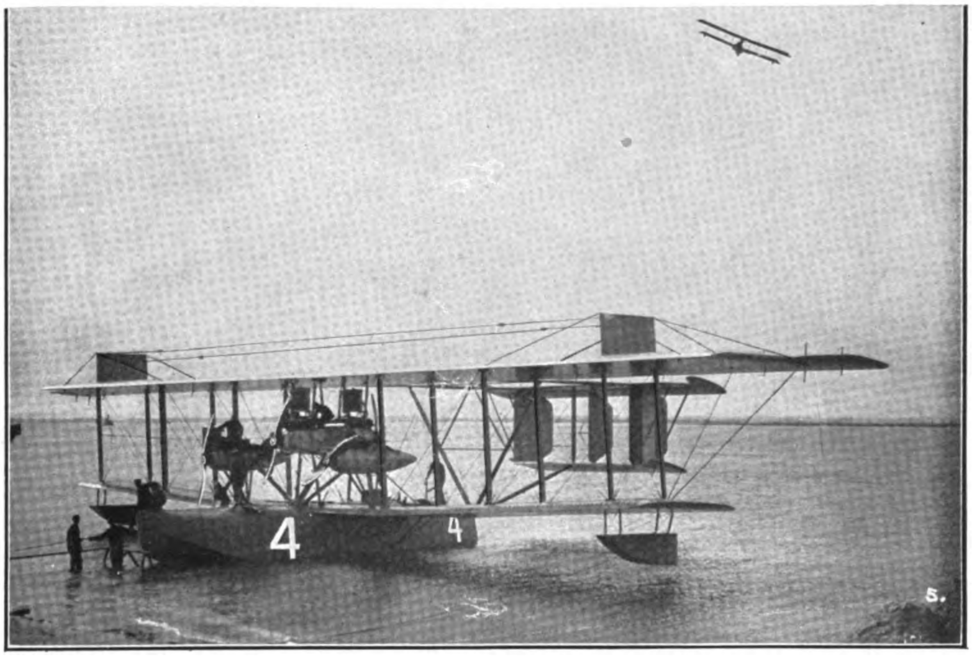

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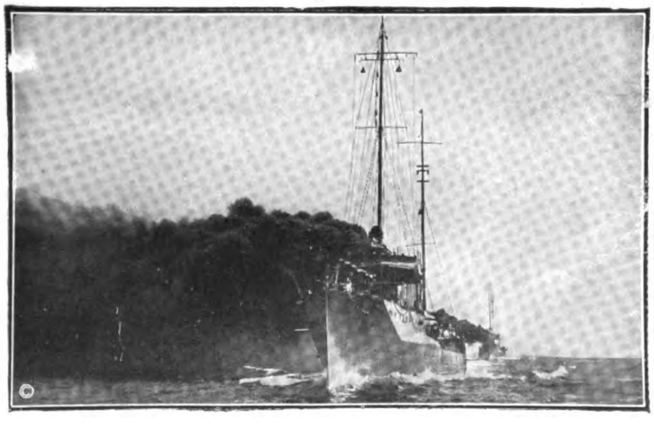

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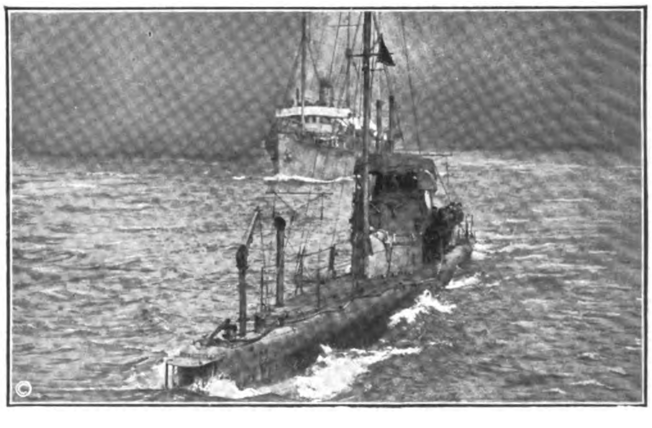

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Vol. 6 No. 11

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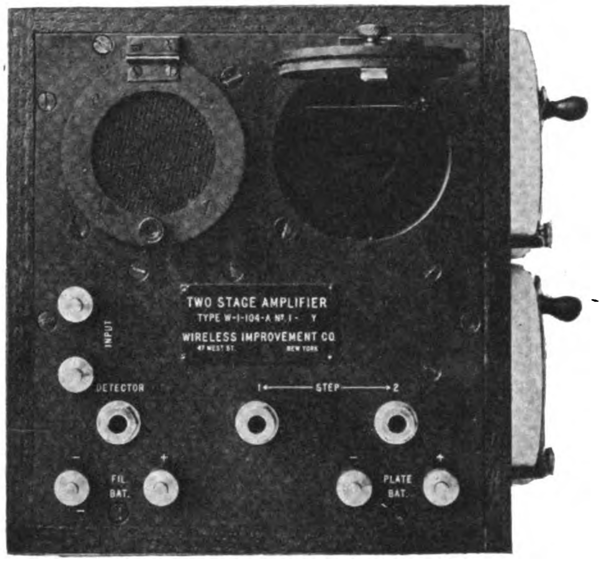

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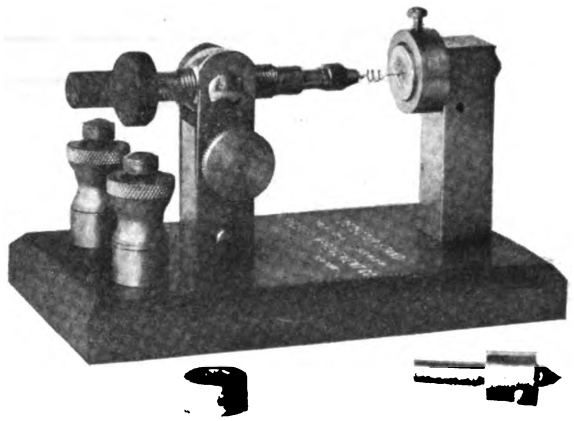

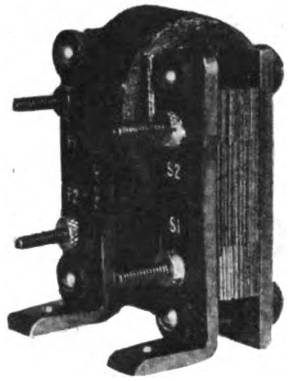

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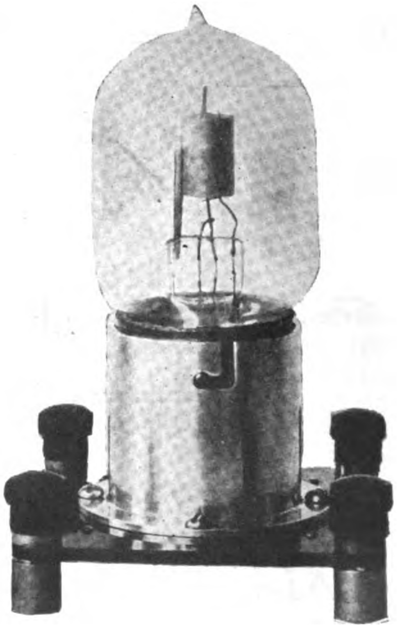


Wireless Improvement Co.

47 West Street New York

Vol. 6. No. 11. August, 1919

THE WIRELESS AGE

WORLD WIDE WIRELESS

Allies Undamped Wave Sets Fooled German Airmen

AMERICA and the Allies outwitted German airmen by means of the wireless telegraph. A captured German army order made public by the army air service shows the importance which the German military leaders attached to wireless, also that they were anxious to duplicate it. The order reads:

"The enemy has found it possible to use wireless installations for undamped waves in his aeroplanes. So far few fittings of this type of apparatus have been captured by us, and in order to enable us to make use of this as soon as possible and also so as to save millions which would have to be spent in experiments, it is every one's duty to see that all wireless telegraph fittings from captured airplanes are saved as completely as possible. Even the smallest pieces will be collected, as a tyro cannot recognize the value and importance of small parts to the expert.

"In view of the importance of these fittings for our own wireless telegraphy, sums paid for this salvage will be high."

The order was dated June 6 last year. It indicates that the Allies were far ahead of the German radio experts and that Germany was prepared to spend millions to bring her equipment up to a point where it would be equal to that of the Allies.

This is one of the reasons why the American aviators when forced to land on German territory burned up all their machines and equipment. In fact, the order shows that Germany did not know the United States had developed the practical wireless telegraph and telephone for airplanes until long after it had been in use.

Airplane radio telegraph sets of the continuous wave type were used by the Allies as early as the spring of 1917.

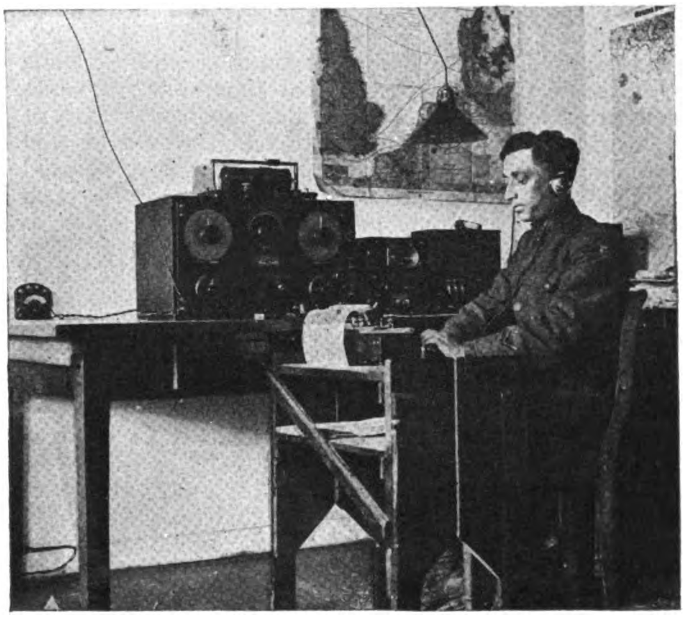
British South Pole Expedition to Use Wireless

A SIX years' polar expedition by British explorers and scientists to the South Pole, in which an aeroplane will be utilized in accomplishing the final stages of the trip, is to be started in June, 1920. The proposed expedition, under the leadership of John L. Cope, F. R. G. S., who accompanied the Shackleton expedition as surgeon and biologist, will be known as the British Imperial Antarctic Expedition. Its objects are:

1. To ascertain the position and extent of mineralogical and other deposits of economic value.
2. To obtain further evidence of the distribution and migration of whales of economic value.
3. Generally to extend the knowledge of Antarctica, especially with a view to obtaining further scientific data of economic importance.
4. To investigate the meteorological and magnetic conditions of the Ross Sea area and at Cape Ann in connection with their influence on similar conditions in Australasia and South Africa respectively.

While the expedition is to be gone six years, it will not be cut off from contact with the civilized world, because it will take along a fairly powerful wireless set.

The famous exploration ship Terra Nova will take the expedition to the southernmost parts reachable.



Copying press on high wave lengths at an A. E. F. station at Neuweid, across the Rhine

Magnifying Sound Four or Five Million Times

A MAN'S voice can be made as loud as the cannon's roar; it can be heard two or twenty miles. The ticking of a watch can be amplified until it sounds like breakers on an ocean cliff.

In the stadium at Golden-Gate park the ticking of a watch was made audible all over the grandstand while an athletic meet was in progress. Captain Robert W. A. Brewer, an experimenter, moved off 2,000 feet and spoke quietly to his dog, and the dog couldn't be held. A wireless station recently received a telephoned message from Europe, and through its amplifier startled duck hunters in the marshes eight miles away.

Wireless Compass Station Established at San Diego, Cal.

OFFICIAL announcement is made that the Navy Department will establish a radio compass station at San Diego, Cal. This will permit inbound naval or merchant shipping to adjust compasses through information flashed from the Point Loma Station.

The Future of Wireless and Aviation

SPEAKING at a luncheon of the Aldwych Club recently, Godfrey Isaacs, managing director of the British Marconi Company, told of a new plan his company had for enabling aviators to tell where they were. After mentioning the wireless direction finder, Mr. Isaacs said:

"A further development had given them a new transmitter, which would project into the air a wide divergent beam, something like a searchlight without the light, which would extend over any area required, or, if it was desired, a concentrated beam over some small place, and those beams would convey to the men in the sky automatically the name of the place they were passing over.

"Assuming that a man was passing over the town of Guildford; from the moment he traversed the region over which this beam was playing he would receive the signal, 'This is Guildford,' and would continue to receive that signal as long as he was over Guildford and no longer. In the same way, if he was passing over Windsor Forest he would be told, 'This is Windsor Forest,' and when he came to his aerodrome a beam would tell him 'This is Hendon Aerodrome!' In that way he thought that one of the greatest dangers to pilots in fog and in darkness was disposed of.

"It required very little imagination to see, a little while hence, some thousands or tens of thousands of names being projected into the skies, so that in whatever part of the world an aeroplane might travel, it would be told continuously and automatically where it was. It would be as easy to learn in the skies where they were as in a railway train when they looked out of the window to see the name of a station.

"Similarly these beams could be equipped to lightships or to buoys in fixed and defined positions, so that even when passing over the sea one would know exactly where one was. When that position of things had developed pilots would no longer lose themselves, wherever they might be."

Enlarging on the commercial possibilities of wireless, Mr. Isaacs said:

"A cable required a very big capital outlay, its cost of maintenance was very considerable, and its capacity for traffic was limited. The cost of a wireless telegraph station was moderate, the cost of maintenance was small, and the capacity for traffic was practically unlimited.

"Wireless to-day could do 150 words a minute simplex and 300 words a minute duplex. It would require but a very small mechanical improvement to double and quadruple that number of words transmitted by wireless." He was quite satisfied that so soon as wireless traffic needed the greater speed of transmission mechanical improvements would be introduced, and they would get something in the neighborhood of 600 words a minute.

Wireless Telegraphy on Board British Ships

LORD SOMERLEYTON'S bill to make further provision with respect to wireless telegraphy on British ships has been issued. It provides that every sea-going British ship registered in the United Kingdom, being a passenger steamer or a ship of 1,600 tons gross tonnage or upwards, shall be provided with a wireless telegraph installation, and shall maintain a wireless telegraph service which shall be at least sufficient to comply with the rules made for the purpose under this Act, and shall be provided with one or more certified operators and watchers.

The Board of Trade may exempt any ships if they are of opinion that, having regard to the nature of the voyages or other circumstances the provision of a wireless apparatus is unnecessary or unreasonable. The Board of Trade, in consultation with the Postmaster-General, shall make rules prescribing the nature of the wireless telegraph installation to be provided, of the services to be maintained, and the number of operators and watchers to be carried. If this section is not complied with the master or owner of the ship shall be liable in respect of each offense to a fine not exceeding £500, and any such offense may be prosecuted summarily, but if the offense is prosecuted summarily the fine shall not exceed £100.

"Passenger steamer" shall mean a steamer which carries more than twelve passengers.

New Wireless Station to Be Built in Cincinnati

CAPTAIN J. P. GRAY, of Washington, a member of the U. S. Coast Guard service, recently visited Cincinnati to make a preliminary survey of possible locations for a Government wireless station there. It will be used for the army, the Weather bureau and other departments.

Dutch East Indies Get Wireless Station

ACCORDING to the Dutch East Indian Commercial Review, a wireless station is now being erected in the Dutch East Indies to transmit messages from Holland direct to the East Indies without relay. The Review says: "The receiving station for the wireless communication between Holland and the Dutch Indies will be erected at Boxmeer (North Brabant), the sending station near Apeldoorn (Gelderland). The station near Apeldoorn gets six masts, 210 meters high. The distance between Holland and its D. E. I. colonies is 11,000 kilometers and this distance will be reached without substations."

Wireless Aids President Wilson in Governmental Work

INDICATING that the public business—or at least some of the public business— was not to suffer while he was away, President Wilson signed appropriation bills aboard the George Washington and a wireless was sent the White House that they had become law.

Such action has been approved by the Attorney-General, and was taken by the President when the first Urgent Deficiency Bill was passed.

The ship is American territory. The White House has become a floating one.

Wireless Telephones Aboard Merchant Ships

EXPERIMENTS in wireless telephony from a merchant vessel, conducted recently aboard the steamship Parismina as she was on her way back from Colon to New Orleans, met with great success.

Should the experiments prove wholly successful, the wireless telephone may supplement the wireless telegraph, now a part of the equipment of practically every ship that goes to sea. Officers in charge of the tests have not yet made a report but it is understood that the experiment bore out the fondest hopes of those in charge.

The messages, from reports, were picked up perfectly at shore stations and the voice was heard as distinctly as is the every-day telephone conversation on shore.

Replies as received from radio operators at sea showed that the voice was distinctly heard, even at long distances.

In the Wireless Room With Marconi

THE Italian who has most appealed to the American imagination, however, is Guglielmo Marconi, says Isaac Marcosson, in the Saturday Evening Post, "I did not meet him until after the outbreak of the war, but I saw him many times and in varied circumstances—at sea, in London, and in Rome. Marconi is slight, nervous, emotional. He speaks English fluently and his wife was English. He is one of the most accessible of men and from long experience knows the interviewing ropes.

"In war as in peace his greatest invention has an immense value. Without wireless some of the most vital phases of the great struggle would have been impossible. The historic S O S call of distress, flashed across the troubled seas, is the world's supreme life saver.

"Marconi made possible one of the unique experiences I had in the war," the writer notes. "In July, 1917, we were fellow passengers on the old American liner St. Paul, then bound from New York to Liverpool. Then—as throughout the war—the wireless room on a steamer was a sacred and inaccessible domain. Only the ship's officers were allowed to enter it.

"One night when we were in the heart of the danger zone—and the submarines were then at their worst—Marconi came to my stateroom and said: 'Would you like to hear how some of the German lies sound in the air.'

"He referred to the German Admiralty wireless reports that were sent out nightly with the news of Teutonic successes.

" 'Yes,' I responded.

" 'All right,' he replied; 'let's go up into the wireless room.'

"We climbed up a slippery ladder and found ourselves in a tiny room where the operator sat at his instruments with the receivers at his ears.

"Instinctively Marconi took the receiver from the operator's head and put it on his own. The master of wireless was on the job.

"Then handing the receiver to me he said:

" 'You can now hear the whole world at war talking.' "

"I listened. To me it was simply a jumble of dots and dashes. Yet that melange of sound was Germany, England, France, America and Italy throwing the fateful news of the day out into the unplumbed spaces."

Marconi and Gabriele d'Annunzio, the Italian poet-soldier, are close friends, Mr. Marcosson observes. Each has a sense of humor strong even in misfortune. Marconi lost an eye in an automobile accident in France and D'Annunzio lost one in aerial combat.

"During the trip to which I have just referred Marconi showed me a telegram which he had recently received from the poet, which read, as I recall it:

" 'We are now two souls with but a single pair of eyes. D'Annunzio.' "

Wireless Whims

IT will be a great day when wireless telephony is so perfected that a man can have a receiver in his hat and be managed by his wife all the time.

"We were much jammed by strong wireless signals not intended for us," Captain Alcock said of the great ocean flight. Big field up there. Great newspapers will have a fleet of planes on the roof where we now have pigeons, and alert young aviator-reporters on dull nights will get an order something like this: "Jones, take the Blurb 4-11-44, tethered at the northeast corner of the building, go up a couple of miles and see if you can pick up a bit of live news."

A miscellaneous collection of wireless apparatus lay on a counter in an electrical store which is the rendezvous of New York wireless amateurs, and a salesman explained that it was pre-war apparatus which was being sold out at special prices.

An amateur stood gazing at a loose coupler which would have been the pride of any amateur a few years ago. The salesman, seeing the interested look of the amateur, approached. "Would you like to buy that loose coupler cheap?" he said. With a sudden look of scorn the seemingly interested amateur replied:

"Naw! I outgrew that stuff long ago. I was just looking at it as a matter of historic interest." And that is precisely the way things go with these ambitious young Americans who dabble in wireless.

Brooklyn Navy Yard Uses Radio Compass

THE radio compass device has reached such a state of development that navigators at the Brooklyn Navy Yard are enabled to give bearings to ships lost in fog off the Atlantic coast.

Left to right—Lieutenant Durrant, wireless operator; Major G. H. Scott, navigator; Major Cook (coatless), part of the crew of the R 34, the dirigible that crossed the Atlantic

The vessels wire the Naval Communications Office when they want assistance. Then, with the aid of several stations, the office fixes the ships' locations and they can proceed without waiting for clear weather.

Increased Wireless Service Across the Pacific

THE present capacity of naval radio transmission across the Pacific ocean will be increased to six times the present capacity by the installation of several automatic high speed sending and receiving apparatus on the San Francisco-Pearl Harbor lines and the opening of a second trans-Pacific radio circuit. Plans for the improved service have already been made in Japan according to the report.

The Speed of Electricity

By A. E. Kennelly, Dr. Sc., A. M.

Vice-President National Wireless Association
Professor of Electrical Engineering at Harvard University;
President of the Institute of Radio Engineers

THE speed of electricity is generally known to be very great, but when a specific question is asked as to what is the speed of electrical transmission of signals over wires, as in telephony, or over a wire and the ground, as in telegraphy, or over the ground alone, as in radio communication, it is very difficult to find a precise answer. Nevertheless, the answer to such a question is of great practical importance in certain engineering undertakings, such as the establishment of the longitude of a station by electric signals from another station whose longitude is already established. Moreover, the subject is of great intellectual interest. Its study has occupied the lives of many scientific investigators. The boundaries of this field of inquiry are far reaching and numerous. They touch upon relativity, the question of infinity in space and time, and the very framework of the known universe. It is only proposed to discuss here a very small part of this vast subject; namely, the speed of electricity insofar as it relates to electric signals, and particularly to radio signals.

VERY BRIEF HISTORY

Prior to Maxwell's time, the speed of electricity over wires was considered as distinct from the speed of light, both experimentally and philosophically. It was realized that the speed of electricity was numerically of the same order as that of light; but the phenomena were regarded as independent. Wheatstone, in 1834, made some laboratory measurements, with a revolving mirror, on the delay of a spark discharge across a gap in the middle of a long wire loop, as compared with a spark across the sending terminals, from which the apparent speed of the current over the wire was 463,500 kilometers per second; but very different results were obtained in various repetitions of the experiment; so that this method of making the measurement was for a long time discredited.

Maxwell's theory, in 1867, of light as an electromagnetic phenomenon, changed the aspect of the question. Assuming that the theory was reliable, it became unnecessary to measure the speed of electrical currents, because the speed of light had already been measured with a fair degree of precision, and bid fair to be measured with yet greater precision in the future.

Maxwell's theory, when first enunciated, depended in a large measure for confirmation upon the corollary that the speed v of transmitting electromagnetic disturbances perpendicular to their wave front is

$$v = \frac{1}{\sqrt{k\mu}} \qquad \frac{\text{cm.}}{\text{sec.}}$$

where k is the dielectric permittivity of the medium, or its "specific inductive capacity," and μ its magnetic permeability. This latter value is unity in vacuo and very nearly unity in all nonmagnetic substances. Consequently, if the permittivity of the medium were quadrupled, the speed should be halved. But the ratio of the velocity of light in vacuo to that in a nonmagnetic solid transparent medium, such as glass, is optically defined as its "index of refraction" ν so that the index of refraction of a transparent dielectric should be numerically equal to the square root of its permittivity k. In a fair number of instances, the agreement between measured values of ν and $\sqrt{k}$ was found to be satisfactory, especially when k was measured at relatively high frequencies.

Maxwell's theory also received support from the fact that it required the ratio of the units in the electrostatic and magnetic C. G. S. systems to be simple functions of the velocity v of electromagnetic wave propagation, or of light. Thus, taking the units of capacitance, if an air condenser had its capacitance measured in abfarads and also in statfarads, the number of statfarads should be v^2 times the number of abfarads. This ratio checked satisfactorily, and is now regarded as perhaps the most precise method of determining inferentially the velocity of light.

Sir Charles Wheatstone in 1834 added to the knowledge of electrical measurements by his research work and laboratory experiments

Hertz's experimental researches with electromagnetic waves have confirmed Maxwell's theory, and have established the belief that light is an electromagnetic wave disturbance, optically differing only from electromagnetic waves of the laboratory, in wave length or accompanying frequency.*

The velocity of light has been measured by optical methods† and the best mean result is generally taken as $v = 299{,}860$ km. per second, or 2.9986×10^{10} cm. per sec. The question as to whether this velocity varies with the wave length, has been hitherto answered in the negative, by various astronomical observations, so far as the wave lengths in or near the visible spectrum are concerned, and also so far as concerns the longer electromagnetic waves of the electric laboratory, by the fact that the best value of v obtained from the measurements of the ratios between electrostatic and electromagnetic units, at very low frequencies, are in agreement with the value of v obtained in optical measurements at luminous frequencies, estimated as lying say between 4×10^{14} and 10^{15} cycles per second.

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*The condition of polarisation of light is here left out of consideration. Radio waves are generally agreed to be not merely long-wave light; but also polarised light.

†Encyclopaedia Brittanica "Light," 11th Edition; also Bulletin of the Bureau of Standards, Vol. 3, No. 4, page 603, 1907.

Summing up the accepted beliefs concerning the speed of electromagnetic disturbances in straight lines, we may say that, for practical purposes, the velocity v is very nearly 300,000 km. per second, in vacuo or free space, and is independent of the frequency or wave length. In air, at standard temperature and pressure, the value of k is taken as 1.00055, as against unity for vacuum; so that the speed of transmission in air is taken as less than in free space in the ratio of 1.00028, or only about 3 parts per myriad. The difference between the speed of propagation in air or in vacuo is therefore relatively very small from an engineering point of view. In rarified air, the retardation of velocity is to be considered as still less, or the velocity is still nearer to v in vacuo.

Lord Rayleigh, noted for his discovery of argon, also contributed to the knowledge of electrical measurements by his discovery of the laws of "group speed" of waves

Velocity of Transmission Over Wires

Granting that electromagnetic disturbances move in the free space with the uniform speed v, as above defined, the next question is what is the speed at which they move over conductors?

The answer is that the speed of disturbances over conductors is always less than that in free space. If the conductors are, say, two parallel copper wires, insulated in and separated by a solid nonmagnetic dielectric of permittivity k, as measured as the proper frequency, then the speed of disturbance in the dielectric would be expected to be $\frac{v}{\sqrt{k}}$. But even if the dielectric medium surrounding the two wires is air, for which k is substantially unity, and their distance apart remains uniform, the speed of transmitting electromagnetic disturbances in the air would be v; but the speed of conducting the disturbance along the wires would be less than v; owing to attenuation or absorption of energy into the conductors, or into the insulators supporting the conductors; or finally into the air itself. In other words, the speed of transmitting electric signals over the wires would be less than the speed of transmitting electromagnetic-signal disturbances through the air alone, owing to loss of energy in the wires, or in the insulation. It is believed that if there were no loss of energy, the speed of transmitting the signals over the wires would be v, the same as the speed in a straight line through the air. Suppose, for example, that an electrical dot impulse, of rectangular wave form, is started off along a pair of parallel aerial telegraph line wires from the sending end. The impulse travels through the air guided by the wires. Owing to resistances losses of various kinds, the impulse attenuates, and also changes its wave shape as it proceeds, so that it arrives at the distant end, no longer as a rectangular wave impulse, but as a rounded wave rising gradually from zero to a maximum. The instant when the wave is considered to arrive at the receiving station would depend upon the sensitiveness of the receiving device. A highly sensitive receiver would be likely to register an earlier arrival than a receiver which only responded to the crest value of the incoming wave. The speed of transmission thus not only becomes lower than the speed of advance through the air; but it also becomes difficult to assign. The higher the linear resistance of the wires, the greater the capacitance of the insulators supporting the wires, and the greater the effective radiation resistance of the system, by which the energy in the advancing wave becomes dissipated, either in heating the conductor, or magnetising it internally, or charging the insulators, or radiating off sideways, the lower the speed of signal transmission would appear to be, as judged by the interval of time between an instrument at the sending station recording the starting of the wave, and a similar instrument at the receiving station recording its arrival. If, however, the wires could be made perfectly conductive and the insulators made completely nonabsorptive—so that there were no resistances and no energy losses—then we should expect to measure a speed of transmission of signals over wires equal to v the speed of advance through air. In practice, these ideal conditions are unattainable, and the apparent speed of signal transmission over conductors is always less, and sometimes much less than the speed v of waves in the dielectric, after allowing for its permittivity k. Consequently, the speed of signal transmission becomes an indefinite quantity, always less than v, but having its value dependent upon various considerations affecting the conductors, including also conditions in the receiving instrument.

Group Velocity of Waves Over Wires

If, instead of sending separate impulses or discrete signals over a pair of parallel wires, we send a train of simple alternating-current waves at a steady frequency, then the meaning of the phrase "speed of electric transmission over wires" becomes definite, but still slightly different from that of v the "speed of electric transmission through air." As was pointed out by Rayleigh, what is observed with alternating-current waves is the "group speed" of the waves, which is not identical with, and is less than, the speed of the wave disturbance. The difference is again due to the attenuation or decay of the waves, from losses occurring during transmission. The successively arriving waves are weakened by these losses, but they still remain sinusoidal in shape. The distortions in wave shape of simple alternating-current waves advancing over uniform aerial conductors, due to attenuation, are such as still leave the arriving waves of simple alternating-current form. The wave length of the train is apparently diminished, and the velocity of arrival is apparently diminished, but the frequency or number of waves arriving per second remains the same as the frequency of the waves delivered by the alternator at the sending end. The lower the resistances and losses of energy in transmission, the more nearly the group speed, or apparent velocity of motion, approaches the speed *v* of the wave disturbance for unguided waves in air. Moreover, the higher the frequency, the less the deviation of group speed from wave speed, other conditions remaining the same.

A crude analogy to the phenomenon of group speed retardation is presented in the case of waves of infantry advancing over a plain, and subjected to a progressive attenuation or destruction by gunfire. Each successive wave may, at regular intervals, start off and proceed throughout the journey with a uniform speed of, say, 3 km. per hour. If the distance to be traversed is just 3 km., the waves without any attenuation would take just one hour to make the journey. But with attenuation, the leading wave may be completely destroyed before it reaches its destination. If the speed of transmission is measured by the time that elapses before a wave registers its arrival, this group speed may work out very appreciably less than the actual 3 km. per hour at which the advance of each unit is being made. The case of electric wave transmission under consideration does not contemplate the extinction of entire waves, and the attenuation is a more gradual and regular process; but in both cases, the cause of the retardation is the same.

In laboratory measurements made on the speed of alternating-current waves over parallel wires in air, the group speed has been found to agree very closely with that of *v*, after allowance has been made for attenuation. A number of such measurements have been published.*

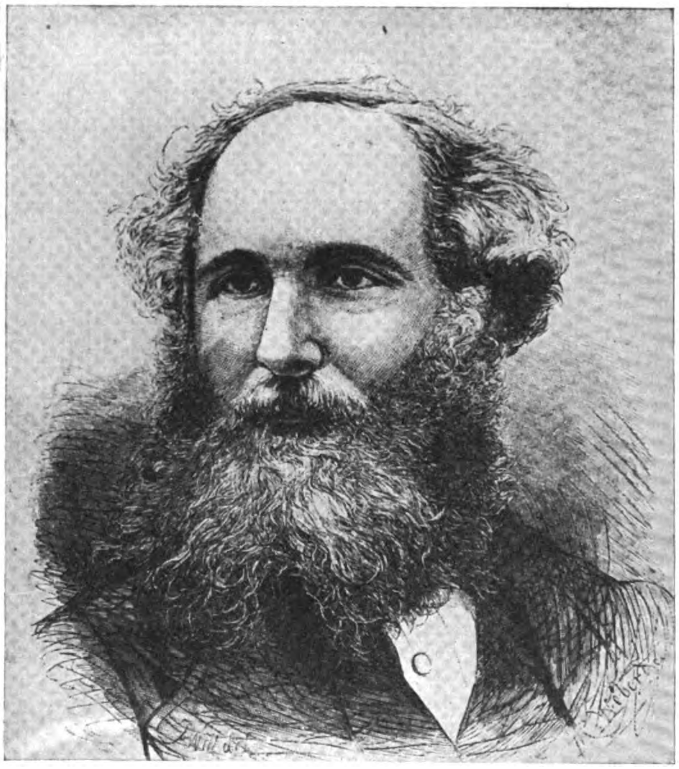
We may, therefore, sum up the matter of alternating-current wave transmission over uniform wires by saying that the observed group speed under favorable conditions can be brought very nearly up to *v*, and that in other cases where the conditions yet remain simple, the reduction in the apparent or group speed can be explained.

Speed of Transmission of Radio Waves

A long train of radio waves advancing hemispherically over the conducting surface of the sea may be regarded as a case of alternating-current transmission over a large conducting surface. If the sea were a perfect electric conductor, and if the earth were flat, and the atmosphere a perfect insulator of $k=1$ throughout, we should expect that the observed group speed of transmission would be identical with *v* the speed of wave transmission in space. The question is, what will be the speed over a spheroidal earth with actually imperfect conductivity in the land and sea, and imperfect insulation in the atmosphere? The curvature of the earth will have a certain retarding influence, owing to the interference of perpetually bending alternating currents, or what corresponds to diffraction† in optics. The imperfect conductivity of the surface and the imperfect insulation of the atmosphere involve losses of energy which probably tend to reduce the group velocity. Moreover, these factors are not independent, but mutually influence one another. Thus, the conductivity of the ground surface affects the diffraction, and so also does the question of conductivity in the upper layers of the earth's atmosphere.

There seems to have been only one series of measurements, thus far published, concerning the group speed of radio signals. This series was made in 1913, by a French commission, in a determination of the difference of longitude between stations in Paris, France, and Washington, D. C., with the aid of radio signals.* The great-circle distance between these stations is given as 6175 km. The received radio signals were photographically recorded. The report states that the transmission interval of these waves was found to be 0.021 second. If we assume that this value is exact to the last decimal, the group speed would be $6175/0.021 = 294.050$ km./sec., which is approximately 2 per cent less than *v*. Probably all that we are justified in inferring is that the difference between the group speed and *v* was not great.

If the group speed of alternating-current radio signals traveling around the globe did not differ appreciably from *v*, then because the distance from any point on the earth to its antipodes is very nearly 20,000 km., it follows that the time required for the waves to leave a sending antenna, run around the world and reach the antipodal antenna, would be $\frac{20,000}{300,000} = \frac{1}{15}$th second. We must expect the actual time to be a little longer than this. Just how much longer, we cannot know assuredly until measurements over similarly long radio distances have been secured. At present, they are very difficult to secure. It will be surprising, however, if the semi-girdling time exceeds the *v*-time of 1/15th second by more than a few per cent. It is generally believed that the actual time is not very much greater than the *v*-time.



James Clerk Maxwell who, in 1867, advanced the theory that light was an electromagnetic phenomenon

It is interesting to reflect that all the nations of the world are thus either actually, or potentially, in probable mutual radio connection within less than one-tenth of a second of time. On a strict *v*-time basis, they would certainly all be within one-fifteenth second.

It seems unreasonable to expect that we mortals can indefinitely continue to maintain differences of language, of customs, of laws, or of weights and measures, on the surface of a radio deci-second globe. In this thought there is brotherhood and mutual good cheer.

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*See a paper by Saunders "On the Velocity of Electrical Waves", in the Physical Review for 1896, Vol. 4, page 81. A good bibliography of the subject appears in this article.

†The Transmission of Electric Waves over the Surface of the Earth, by A. E. H. Love, F. R. S., Phil. Trans., R. S., Vol. 215, pp. 105-131, 1915. This paper contains a bibliography of the subject.

*Comptes Rendus, June 13th, 1916. Vol. 162, pp. 899-903.

Across the Ocean on the NC-4

The Personal Narrative of the Wireless Operator on the Naval Seaplane Which First Spanned the Atlantic in an Historical Air Flight

By Ensign Herbert C. Rodd

Ensign Rodd

I EXPECT that it is up to me to tell, as best I can, just what happened in wireless when the NC-4 made the historic flight across the Atlantic.

The explanation of how the radio equipment was used, and the very great assistance it afforded us, presents no difficulty; but the thing which I find very hard to reconcile with this workaday job is bathing the task in the floodlight of an heroic action. I simply cannot view it that way. The wireless operation of the NC-4's equipment was carefully planned and easily executed; I must say at the start it required no special effort of the superhuman order, as many of the descriptive writers have pictured it. My principal impression of the part I played in the history-making episode is a sense of gratification that the selection of this task happened to fall on me.

The flight in itself was extremely interesting, and I can truthfully say that the success of the wireless communication exceeded all my fondest expectations. If I can convey in this article and its successors, exactly what was accomplished in radio communication during the flight, tell the tale without any embellishments and make the reader understand by inference, more than by power of descriptive writing, how fascinating the manipulation of the apparatus became, then I will feel that the purpose of these articles has been achieved.

Let me first briefly describe the apparatus. The NC-4 had a 500-watt propeller-driven spark transmitter, a 5-watt battery-driven telephone transmitter, an aircraft type receiver and a radio compass equipment consisting of a revolving set of coils operating in conjunction with a compass control panel and an amplifier. Transmission and reception was arranged for either on an antenna stretched between the skid fins on the upper plane, or on a single-wire trailing antenna. The apparatus was located in the aft portion of the boat and was arranged as shown in one of the photographs accompanying this article.

In this photograph the reel of the trailing antenna may be seen to the extreme right. Alongside is the variometer assembly for the spark transmitter. A large special send-receive switch was mounted against the side of the boat; below this on the table may be seen the telephone transmitter and the switch by means of which the amplifier could be used in conjunction with the compass equipment or with the standard receiver. The wave length of 1,500 meters was the one arranged for most efficient operation of the compass. The inter-communicating telephone system was arranged so that the radiophone could be used by either Commander Read, located forward in the craft, or by myself as operator.

During the trans-Atlantic flight I kept a very complete log and this enables me to describe nearly everything that happened, right from the beginning. I am unable to give the exact wave length on which each communication was copied, but it may be generally understood in all that follows that 1,500 meters was used by the destroyers, except when I requested them to transmit on 1,200, 952 or 756 in order to eliminate interference. Communications from the NC-4 were transmitted on a wave length of 425 meters. As we passed each destroyer the time by the clock was immediately broadcasted on 756 meters and this information was then broadcasted by me on 425 meters.

Dispensing now with the earlier preparations preliminary to the actual attempt to fly across the ocean, it may be said that it was on May 6th at 3:30 in the morning when the radio installation on the NC-4 was completed. Within an hour we were expected to make ready for the start, but an unfavorable weather report came in and the flight was delayed, giving me the opportunity to spend most of the day in the boat selecting vacuum tubes for both the amplifier and continuous wave transmitter.

When Norfolk station began on the afternoon schedule, I took bearings, to make sure that the fixed condensers in the radio control panel were adjusted to 1,500 meters. A wavemeter had verified the adjustment, but no tests had been made with the station actually working. The variable condenser in the control panel had a capacity of but .0005; because of the extra weight of larger condensers a fixed capacity was shunted across each variable.

There had been no opportunity to test the radio apparatus in flight, and it looked very much as if the NC-4 would leave Rockaway without knowing whether things would function when the plane took the air. On the following day, however, the weather cleared and at 5 in the afternoon we had everything in readiness to make a test flight. The boat was taken out on the runway and just as we were about to slip down into the water the engineer officer put his foot through the generator's propeller, breaking both blades. This accident was due to the fact that the center engine was running and its tractor propeller had caused the air screw of the small generator to run at such high speed that it was not seen.

A most unfortunate accident also occurred at this time. Chief Special Mechanic E. Harry Howard caught his hand in the propeller, severing the member completely at the wrist. He showed a great amount of grit by refusing to be helped down from the plane, and so challenged our admiration that had it not been our last chance for the test flight, we certainly would have given it up for the day. It was rather rough on Howard to be eliminated from the flight at this late date and we all extended our deepest sympathy to him.

There was no time to be lost, however, as it was growing dark, and when I told the Navigator that it would probably take fifteen minutes to change the generator air screw, it was decided that we would leave without effecting repairs.

This flight gave me an opportunity to test the continuous wave transmitter with the station at Rockaway. The skid-fin antenna was used and the buzzer signals were easily readable in the air. I found, however, that the telephone did not work to full satisfaction, except when the plane had come to rest on the water with the motors stopped. This was the first time I had tried out the trailing antenna arrangements and the ease of operation of the metal reel surprised me. We remained in the air about two hours, which gave me the opportunity to hear a sufficient number of distant stations with the amplifier and warranted no worry on that score.

The following morning at 4:30 the eventful moment of the start arrived, for it was then that we were awakened and told to make our final preparations for the departure. At 8 o'clock everything was ready; all mechanical and electrical needs had been provided for and food and coffee in Thermos bottles had been put aboard. Especially thorough was the preparation for personal solace in the form of nicotine. Each man had been allowed five pounds for personal effects, exclusive of his flying equipment. Kit bags made of light balloon fabric were provided, and I feel quite certain that had these been weighed after they had been put aboard, they would have found that the limit was well exceeded on account of the generous stock of cigarettes supplied for each man. As a final touch, Captain Irwin presented members of the crew with four-leaf clovers.

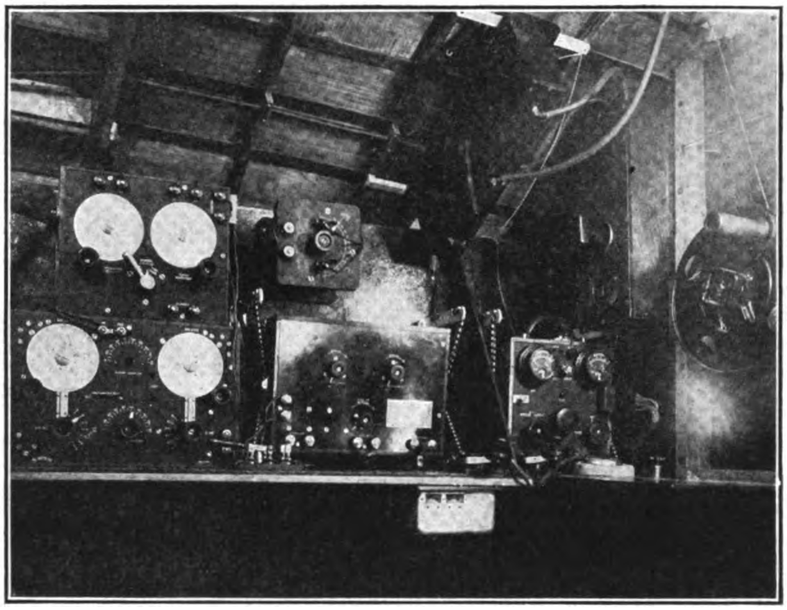
We left Rockaway at 10 in the morning of the 8th of May, my seaplane getting off just after the NC-3 and just before the NC-1. Several other planes accompanied us for a distance of perhaps 25 miles; these were equipped with moving picture cameras and recorded the early stages of the eventful trip.

It did not take me long to get down to business. The immediate result was nearly fatal, for I was ready to jump out of the cockpit with joy when, upon throwing in the field switch and depressing the key, a beautiful spark note greeted my ears through the head phones.

It was a great relief to know that everything was hooked up properly, for I had feared that in the rush, and because of the necessity of working outside of the hangars at night with a poor light, we might have mixed up our power leads. When I adjusted the variometer it showed a radiation of 3 amperes on the skid-fin antenna, and the NC-1 came back immediately, saying that my spark was good. A little personal touch was added then by a good-luck message which came to me through the ether signed by Wise, Jones, Parks and all the rest—radio electricians who had worked to get us in shape.

Twenty-seven minutes after we hopped off, all three of the NC craft had adjusted things and we were in communication with each other. Three minutes later New York and Boston broadcasted that the NC boats had started the trip to Halifax. It was then that I let out my trailing wire.

There seemed to be something doing every minute. Less than three-quarters of an hour after we had started there came a congratulatory and goodluck message from Admiral Coffman, Commandant of the Third Naval District. Within five minutes I received a long message via Rockaway which had come from Admiral Knapp in London, stating that the British Air Ministry had made arrangements to extend every facility and convenience to the NC flying boats at Plymouth when the trans-Atlantic flight had been completed. We were offered the Air Station in the Scilly Islands as a temporary repair or refueling point. I recall that at the time this message seemed a little far fetched, but with it came a feeling of appreciation of the undeniable cordiality of the British and their interest in our success.



The wireless apparatus located in the aft part of the NC-4. To the right may be seen the reel of the trailing antenna, alongside is the variometer; the send-receive switch is attached to side of boat; below that the telephone transmitter and switch for amplifier to be used in conjunction with compass equipment or standard receiver

Fire Island called a few minutes later and wished us good luck. We had then been in the air less than an hour and a half, and I told Rockaway "Everything O. K. 2,000 feet altitude." As I completed this message, I heard Norfolk transmitting on 952 meters, 400 miles distant.

About this time my deep cupped receiving helmet had become uncomfortable and I changed to one which employed ordinary bath sponges, a helmet which had been made at Hampton Roads by Lieutenant-Commander Taylor—one which I had used with great comfort and success during flights totaling several hundred hours. It might be of interest to note here that Commander Read wore the helmet which had been supplied throughout the entire flight, a very creditable performance because pilots have always worn this type of helmet with reluctance, showing a decided preference for the ordinary type which is much lighter.

We passed Montauk after one hour and fifty minutes of flying. It was here that I got a bearing on Philadelphia on the 1,500 meter wave length. It checked up roughly and the signals came in loud on the radio compass. This early indication that the direction finding apparatus was O. K. was very reassuring.

During the next hour I heard the NC-3 working with destroyers No. 1 and No. 2 which lay off Boston and were sending weather reports. New York also asked us to listen for his telephone at 1,200 meters, but it was not audible. Then I heard the operator at Siasconset station asking if we had anything for him. A message from Assistant Secretary of the Navy Roosevelt arrived a minute later.

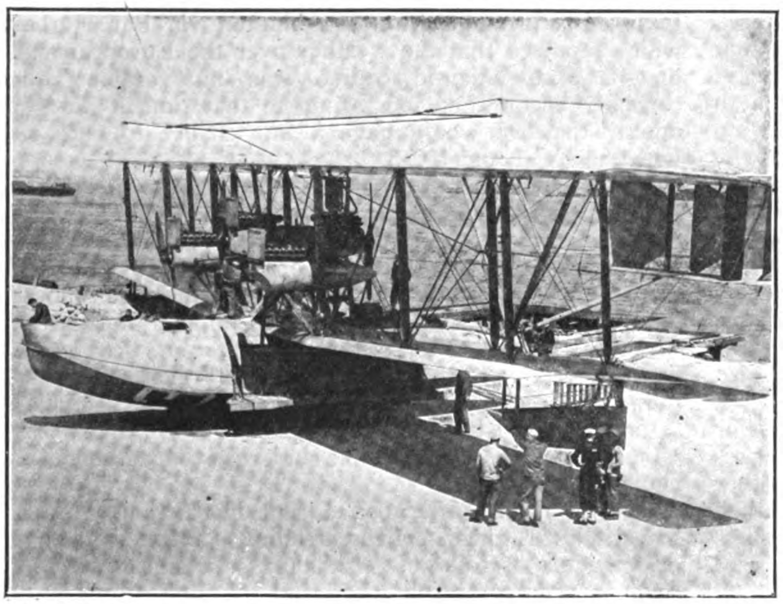
The next use of the apparatus was of a practical order, demonstrating its value in navigation. The 1 o'clock time tick from the high power station at Arlington came in strongly, and I switched on to the Navigator's phones so that he could check his chronometers. Immediately afterward the air station at Chatham requested our position, and relayed a message from the "Baltimore" at Halifax, giving weather conditions at that point. This report contained the disturbing information that an hour earlier the northwest wind had a velocity of 37 miles per hour. As this was an important matter for the information of the Navigator, I immediately sent it forward to him.

When we had been in the air four hours and a half the Navigator instructed me to inform the NC-3, our flag-plane, that we had passed over destroyer No. 1 and that we were now running on three motors. In spite of the loss of part of our propelling power we had been keeping up with the other planes, but for some little time it had been noticed that something which looked like oil was streaming out of one of the center motors. Had it not been for the leak here which drained the oil from the forward center engine, we would have made Halifax all right; but when that motor went dead it immediately became evident that with our loss of altitude, which had been rapid, we would not be able to fly far with only two engines in operation. So both center motors were cut off and we glided for landing.

I tried to send during the glide, but could not get a spark, so the destroyers were not informed that we were coming down. The air screw of the generator was located in the propeller slip stream and it was afterward determined that the generator screw turned only when the center tractor was running, showing that the air speed of the NC-4 did not influence the speed of the generator.

The accident which brought us down was the breaking of a connecting rod in one of the motors. A big piece was knocked out of the crankcase and it is still a matter for wonder that no one was hurt and that the pusher propeller was not injured by the flying bits of aluminum.

Immediately after the landing I was given a message to send in the event that I could raise one of the stations. It gave our latitude and longitude and stated that we would probably not require assistance. I called destroyers No. 1 and No. 2 at Chatham, but they were busy on higher wave lengths and I received no reply. I was not surprised at this, because all continuous wave transmitters tune very sharply on the receiving end, especially on the shorter wave lengths. Still, I thought that within an hour or two sombody would happen on our tune. All night long, whenever I noticed an opening, I sent out SOS signals. We were not in any danger but I figured the ordinary call might not attract attention. I kept up the sending on the buzzer, modulated with radiation varying from .5 to .8 ampere, according to filament input. There was no response.


The NC-4 at Rockaway Point receiving the final inspection previous to the trans-Atlantic flight

During the first five hours of the ensuing "taxi" in the light craft, there was a heavy sea running and it pitched the NC-4 about like a cockle-shell.

While we were on the water Bar Harbor and Cape Sable could be heard very plainly working the NC-1 and the NC-3. Communications from ships 300 miles at sea and the responses from stations at New York and Boston were also heard. The practicability of the radio compass was illustrated in one instance by an inquiry from a ship, supplemented by the statement that she had been without astronomical observations for thirty-six hours; New York replied that her signals were Q R Z, and Montauk could hear her on the radio compass.

Our first "casualty" then occurred, the engineer officer became slightly indisposed, necessitating his turning in. The "corpse" looked very comfortable as it lay stretched out on the grating with life preservers used as matresses.

We were able to make about eight knots running on the two outward motors, and although it would have been possible to shift the air driven generator to an outward strut in the slip stream of the propellers, the situation did not seem to warrant it. We were getting along nicely and in making this change I recognized the possibility of putting a foot through the wings or losing a set overboard.

Up to 10 o'clock that night the destroyers could be heard maintaining almost a continuous run of wireless conversation, inquiring whether the NC-4 had been seen and telling each other what course they were patrolling. Their signals came in so loud that they were heard by the Navigator in the cockpit forward, nearly fifty feet away. He suggested that I take bearings on them and determine which one was the nearest, but even though on the skid-fin antenna they could be heard strongly, the transmission was on 756 and 952 meters and the signals were inaudible on the compass coils. This was due to the fact that the range of the compass panel extended only about 200 meters above and below its wave length of 1,500 meters.

An hour after midnight we sighted a ship and signaled with the Aldis lamp, but received no answer. At another time we were within sight of a destroyer, but the operator was apparently not listening in on short wave lengths, for I signaled long and loud with a telephone set without any response. At two in the morning Siasconset's signals were coming in unusually strong, and for an hour I hailed the shore station continuously but could not get the operator's attention. Nor did anything happen when I called Chatham Air Station, but shortly after five in the morning we made the entrance of the channel at Chatham and it was only then that I heard the station there informing the destroyers that the Coast Guard Station had sighted the NC-4. We had established a long distance "taxying" record, having covered 125 miles in fifteen hours.

The boat from the air station came out to meet us and we reached the dock at Chatham two hours later. There we learned that two airplanes had been searching for us without success, probably because they were not carrying wireless operators.

A hearty reception awaited us at Chatham and the officers' mess turned out a breakfast that would be hard to beat. Having disposed of this welcome meal, we instructed the mechanics on the installation of a new motor and then turned in for a few hours needed sleep.

That evening Captain Eaton drove us to the village. It proved to be the town in which Commander Read had lived when a boy, and he pointed out the house occupied by his father, who had been pastor of the church, and he also recognized the school house which he had attended at the age of nine.

We stayed at Chatham for five days, experiencing a regular old Cape Cod Northeaster, with continuous rain and a wind that blew at the rate of 35 miles per hour. There was little to be done to the wireless equipment; in fact, the only attention required was charging the storage battery. This battery had run the 6-tube amplifier continuously for 22 hours, and the continuous wave set for 2 hours—approximately a discharge of 80 ampere hours—with no signs of deterioration. Visits to the plane and thorough inspections were daily occurrences, however, and everything was kept well covered with balloon fabric to protect it from the driving rain.

Although every assistance and encouragement was given by Lieut. (j. g.) T. A. Hoopes, radio officer at Chatham, I must confess that at the end of the fourth day I would have sold at a bargain price my chances of making a trans-Atlantic flight. NC-4 stock went up, however, when on May 13th we received a favorable weather report, supplemented by the information that the weather between Trepassey and the Azores was not favorable for starting. This relieved our anxiety that the other planes at Trepassey might get good weather and hop off without waiting for us.

The following morning, at ten minutes after 8 o'clock, we made a short flight to inspect the propellers and clear an oil line; during the eight minutes in the air I worked Chatham on the skid-fin antenna and was well satisfied that everything would function properly in the operation of the wireless equipment. At 9:07 a. m. we got away, and fifteen minutes later I heard in my head phones the news of our departure being broadcasted by wireless from Boston. A few minutes later the station at Fire Island called the C-5. This call came as a surprise to me, for though we had heard that the dirigible was contemplating a trip to Newfoundland, this was the first intimation that we had that she had started. Twenty minutes later we had passed over destroyer No. 1 and everything went along quietly for about an hour. Then Chatham inquired how much "gas" we had taken on and informed us that the C-5 had passed over that station at 10:10 a. m. A few minutes later I heard Bar Harbor call and tell me to stand by to receive a rush message from Washington, to be answered immediately and relayed to all parts of the world. It was a long weather report which he sent on 600 meters and afterward shifted to 1,400 meters.

This message was followed a half-hour later by a communication from Assistant Secretary of the Navy Roosevelt reading, "What is your position? All keenly interested in your progress. Good luck." In the short space of two minutes the following reply had been sent: "Thank you for good wishes. NC-4 is 20 miles southwest of Seal Island, making 85 miles per hour. Read"

Immediately afterward Chatham asked by wireless for a report for Commander Whiting, giving our total loading, amount of gasoline we were carrying and other details. Hardly had this communication been finished when Bar Harbor radioed a complimentary service message; it read: "Took three minutes for Roosevelt to send despatch to NC-4 and receive your reply. This beats all known records."

The next communication came about twenty minutes later; it was a weather report from Cape Sable. The operator at that station then told me informally by wireless that we looked fine as we flew over. I replied that his station had looked so good to me that I had taken a snap-shop of it, a detail apparently of great interest to him for he immediately requested me to mail him a print of the photograph if it was good. Unfortunately I had only an ordinary vest pocket Kodak with a lense not sufficiently fast, and the picture was a failure. Not knowing the operator's name, I take this opportunity of informing him of the reason why the souvenir has not arrived.

Shortly after noon I started working the Cruiser Baltimore at Halifax, telling them that we would land there for a few minutes, for at that time we expected to keep on to Trepassey. Within a half-hour we had flown over station No. 4 and received his position by wireless. The air then became very "bumpy" and as we were going into Halifax it became very difficult to remain sitting on the small stool with which I was provided; it was almost impossible to send decently. I had managed, however, to tell Bar Harbor that we would land soon and I must say that operator "DN" at that station was certainly a good man on the key; it was a pleasure to work fast with him.

We landed at Halifax without incident, having accomplished the run from Chatham in four hours. For this reason the storage battery still read high, but I observed the precaution of having it charged in the engine room of the "Baltimore." Our intention to remain at Halifax only a few minutes was set aside by the necessity for changing propellers. The type which had been used thus far on the trip was a new one, and the air screws already showed signs of weakening, so it was decided to make a change and to delay the flight to Trepassey until the next morning.

We made an auspicious start for Trepassey at eight minutes to 9 on the following morning, but lack of oil pressure in the center tractor motor forced a landing a half-hour later. It was then that I established communication with the "Baltimore" and the Camperdown station with the small battery set. This apparatus had failed to reach anybody at Chatham, but without any changes whatever in adjustment, it worked these stations very well at a distance which the Navigator told me was 18 miles. Camperdown station, however, could not hear the continuous wave telephone, probably because he had a non-oscillating circuit receiver.

After we had remained on the water for several hours I copied a message from Washington via Bar Harbor which reported that the weather over the European end of the trans-Atlantic course was unfavorable; this certainly encouraged us, for up to that time it did not appear that we would have a fair chance to take off with the NC-1 and NC-3.

We left the water at Story Head at 11:47 a. m., and for something over an hour Baltimore filled the air with message traffic with the station at Bar Harbor. When we were passing Cape Canso, about an hour and a half after our departure from Story Head, the "Baltimore" inquired our position, which I gave him. Immediately, the Canadian stations began to send out broadcasts, requesting all ships to restrict the use of their radio, and each in turn wishing the NC-4 the best of luck. Compass signals followed from destroyers No. 1, No. 2, No. 3 and No. 4, which were all audible and received without difficulty.

At two in the afternoon I sent instructions to destroyer No. 1, the Stephens, reading: "Request change in procedure as follows. As soon as seaplane is sighted, steam on course at full speed and continue course until next destroyer or station reports plane passing." Had this arrangement been in effect at Chatham, it would have solved our difficulties, for back there we had landed just between two ships.

A few minutes later I asked destroyer No. 3, the Robinson, for a weather report and received it in six minutes. Within a half-hour the same message had been sent to destroyer No. 2 and his reply was also received in six minutes.

It was ten minutes to 3 o'clock when we flew over destroyer No. 1 and at that time I was working with the Baltimore at Halifax. Captains Simpson and Lee both sent messages to Commander Read, who replied that he hoped that he had not kept them waiting too long. Immediately the response came back they were not the least bit tired.

At 3:25 in the afternoon we passed over destroyer No. 2, and twenty minutes later had left No. 3 behind. It was about this time that I saw my first iceberg. From a distance the bergs looked like sailing ships, an impression which was also held by Lieutenant Hinton until we had quickly covered the distance to them. I find in my radio log the entry "temperature getting low"—an observation which was made as we passed over the ice floes.

The multiplicity of interesting occurrences during this flight was again emphasized within an hour, when I copied the following message "Navy dirigible C-5 broke adrift from mooring at Pleasantville. Rip cord broke. No one on board. No casualties. Edwards proceeding in a northeasterly direction. Ten persons with instructions to attempt bring down with anti-aircraft fire." It was just about this time the pilots sighted her, but the fact was not communicated to me, so no report was sent by radio.

At 5 o'clock in the afternoon I intercepted a message which was a bit of a shock. We had just passed station No. 4 when I heard No. 3 on the Azores leg tell No. 8 that she could not arrive at the station until 1 a. m., that she was taking No. 3 position. This was our first intimation that the other planes were about to start on the overseas flight.

Ten minutes later our motive power again came into prominence and I sent a message to Commander Towers of the NC-3 at Trepassey requesting that arrangements be made to change our forward center motor. This engine was the one which was installed at Chatham and was of a low compression type. It was just as powerful as the high compression motor which we now asked for, but it was slightly less economical in fuel consumption, and a change seemed advisable.

Within half an hour we made our landing at Trepassey Bay. As we approached the harbor the Aroostook sent me a wireless message to be on the lookout for the NC-1 and NC-3 as we came in. As we had surmised, they had made their start overseas! But our great disappointment was somewhat mitigated when we sighted them, for we then saw that their noses were turned back to Trepassey.

As we glided down to the water with the center motor running I sent a message on the skid-fin antenna, punctuated by the mental hope that the mechanics would be ready and able to give us quick service so that the NC-4 would be ready to start for the Azores with the others.

Good service was forthcoming.

We landed at 5:39 in the afternoon. Immediately mechanics clambered aboard and worked like demons all through the night.

Little was needed in the way of attention to the wireless equipment. The battery was charged aboard the Aroostook, new brushes were put in the spark transmitter, and for rubber gaskets under the cover which had pulled out rubber tape was substituted. There was nothing else required but the elimination of many spare parts which we were carrying and wiping up the apparatus with 3-in-1 oil. Every pound of superfluous weight was removed; bulkhead doors were taken off, and we dispensed with heavy tools and an extra fresh water tank, for favorable weather reports over the entire course were received the following morning, and the start that night became certain.

At 6 in the evening of May 15th we left the water at Trepassey, making a landing a few minutes later to wait for the NC-3. The flag-plane came along within ten minutes took off on the great hop across the Atlantic.

The Aroostook was immediately heard broadcasting the time of our departure and requesting that it be passed down the line to all the destroyers.

(To be continued)

Wireless as an Aid to Aerial Navigation

By Roy A. Weagant

Chief Engineer, Marconi Wireless Telegraph Co. of America

ONE question which has been developed by the remarkable trans-Atlantic flights by aircraft is the great advantages to be secured by utilizing wireless equipment for purposes of air navigation. It is reported that Captain Alcock and Lieutenant Brown employed astronomical observation for obtaining bearings, but I think the flight itself illustrates how unwise it is to depend upon this means of navigating aircraft. It is reported that for hours the moon or stars could not be seen, owing to the dense fog and drizzle. Similar handicaps must be regularly expected, and it is therefore obvious that any consideration of the possibilities of cross-ocean flight on a commercial scale must make provision for navigating instruments that function without visual aid.

There are wireless instruments now available which provide for taking bearings under any weather conditions, and for their universal application it merely remains for the radio and aircraft engineers to get together and work out the details of design within the weight and space limitations imposed by heavier-than-air craft. The layman hardly appreciates that present day airplane wireless equipment was developed under pressure of a supreme emergency and that the apparatus has been adapted to the aircraft which existed, whereas under normal development airplane designers would have made provision for taking care of the wireless equipment features. We can expect normal development now, and there can be no question that under proper supervision air navigation will be greatly simplified and made exact by utilizing wireless aid.

The particular apparatus which makes this possible is the Bellini-Tosi directive system, otherwise known as the goniometer, direction finder or radio compass. The operation of this device is very simple. It comprises essentially two coils fixed at right angles and another coil which is rotated within the fixed coils. This exploring coil is connected to the wireless receiver and is moved through the arc of a graduated scale; when the signals are heard strongest in the operator's head telephone, the movable pointer indicates the direction of the incoming signal. The geographical direction is then secured by a glance at the compass. It may readily be seen, therefore, that if signals can be heard from two wireless stations offering a wide angle, say, Clifden, Ireland, and Lyons, France, the aircraft operator flying across the ocean has merely to make a simple triangulation to get his exact bearings.

The densest fog is no obstacle to the receipt of these wireless signals and it remains but to equip aircraft with long distance receiving apparatus to take full advantage of the aid of wireless in trans-ocean navigation.

In the two epochal airplane flights made thus far there has been no opportunity to determine the full value of the directive system of wireless. The American NC flying boats employed the device, but only with short range receivers, as the flight commanders expected to remain within easy receiving distance of the line of destroyers. Had long range receivers been installed the craft would not have had to depend upon these ships for bearings. The same is true of the Vimy airplane, and it will be interesting from a scientific point of view to compare results when in some future flight full advantage is taken of the obvious value of the long distance receiving apparatus.

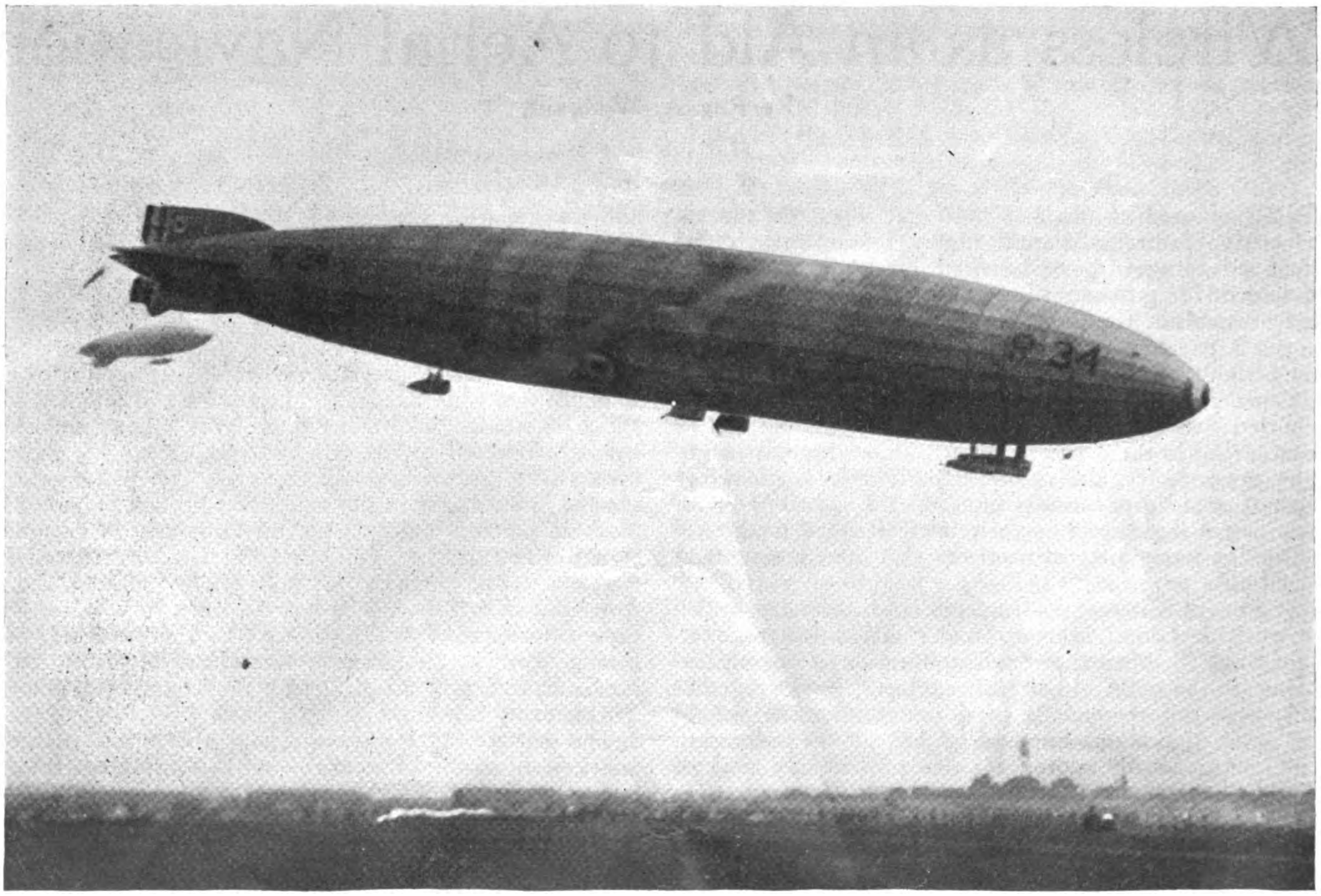
In the speculation regarding the eventual establishment of regular ocean crossings by airplane, account should be taken of the entire feasibility of setting up a wireless path or lane which will enable aircraft to remain on a course in weather when astronomical observation is impossible. To maintain such a path would require merely that three high power wireless stations transmit signals regularly at frequent intervals and that a wide angle be afforded by their geographical position; thus one station in America, one in Europe and one in Africa would be sufficient to guide aircraft on their courses both ways across the Atlantic. Maintenance of these wireless stations for that exclusive purpose would perhaps be prohibited by the expense, but in the not far distant day when trans-Atlantic aircraft will be making daily flights across the sea, the expense, equitably distributed among the air transportation companies, would be negligible. Up to that point, however, it is reasonable to suppose that arrangements could be made so that the three wireless stations could suspend other message traffic operations on the "sailing" days and maintain their paths of signals during the hours when the flying crafts are crossing the ocean.

It may be well to point out also that we have just begun to employ wireless transmitting apparatus on airplanes. In the course of normal development it is to be expected very soon that wireless telephone conversations will be held between aircraft and ships at sea. It then becomes a simple matter for the aviator lost in a fog to get the latitude and longitude from two vessels, determine their direction by the Bellini-Tosi system and know almost instantly his exact position. Another step which is certain of accomplishment is the utilization of wireless as a means of summoning aid if the aircraft is forced to descend on the water. The wind-driven generator which is now in universal use on airplanes does not function unless the craft is in full flight. A generator driven from the airplane engine is therefore essential so that wireless transmission may be effected when the craft is resting on the water. The design of a satisfactory engine drive and provision for charging storage batteries for use when the motor is not running presents no engineering difficulties. This problem, and several others which are not yet worked out to the full satisfaction of radio engineers, are comparatively minor matters when it is considered that in less than a year airplane wireless apparatus has been developed which has a sending range of 600 miles and ability to receive 1,400 miles. It but remains for wireless equipment to be recognized as indispensable for aircraft as it is for ships, a matter which will be appreciated by aviators when they have had the opportunity of properly employing it as an invaluable navigating means as well as a method of summoning assistance.

Wireless Direction Finder the Secret of Alcock's Success

HOW did Captain Alcock navigate his airplane across the Atlantic Ocean through more than a thousand miles of fog and sleet so successfully? How was his navigator, Lieutenant Brown, able to steer the machine to the exact point in Ireland that the two airmen had announced as the terminus of their flight?

"There is not one chance in a million of being able to reach the destination with such accuracy by the ordinary instruments of navigation," says Grover C. Loening,



Press Ill. Svce.

The R-34 hovering over Roosevelt Field, Mineola; this dirigible made two successful cross-ocean flights by using wireless as a navigating aid.

monoplane manufacturer. "Under the weather conditions experienced by Captain Alcock the airplane should have been miles out of its course.

"His story of the flight shows that winds were experienced first from the northwest and then from the southwest. With the fog and sleet that prevailed it was impossible for the navigator even to estimate the drift caused by these winds. His ordinary means of navigation were useless."

Reliable reports state that the apparatus installed on the Vickers biplane was built into the wings of the machine. It was absolutely independent of the other wireless apparatus.

The direction-finding coils were built into the wings, so that when the machine was pointed toward any wireless station signals would be received from that station. Should the machine veer to the right or left signals would immediately cease recording on the receiving apparatus.

So simple in operation is this apparatus that it is also unnecessary for the pilot to understand the signals being sent out. As long as he hears the signals in his telephone headgear he knows he is heading directly toward the wireless station chosen.

This, it is said, is exactly what occurred in the Vickers-Vimy bomber's flight across the Atlantic. The Clifden wireless station is the largest in Ireland, and is in constant communication with Glace Bay, in Canada. The Vickers crew throughout their voyage were able to hear this station, and thereby keep their machine directed toward it, and so overcome the effect of the side drift caused by the winds. This would explain why the machine finished its remarkable voyage right over the tremendous aerials of the Clifden station.

The Radio Compass and the NC Flights

THE NC-1 went to the bottom of the Atlantic and the NC-3 was forced to plunge into the sea during the historic flight from Trepassey Bay, Newfoundland, to Ponta Delgada in the Azores because the radio compasses on the two planes failed to record messages sent from a greater distance than ten miles, and not because they were forced down by storm and fog.

This statement was made by Commander John H. Towers.

Commander Towers's remark concerning the failure of the radio compass, or direction finder—something new to aerial navigation—was the result of a statement made by Commander Read, who had been asked how he happened to reach the Island of Flores under the same atmospheric conditions experienced by the pilots of the other planes.

"I call it just good luck," he said. "I got through the fog bank and caught one glimpse of land. Of course, I knew what the land was and headed for it. I never have been able to understand why the others had worse weather. One was to the north of me and the other to the south of me. Reports received by wireless indicated that the fog was less dense to the south. I was in the centre of the sandwich, so to speak."

"That is perfectly true," said Commander Towers in discussing this point. "Both Read and I were south of the course, which lay between the Islands of Corvo and Flores. When I was off Flores I too got one flash of the sun and made an observation, but I didn't trust it. Later, I wished I had as it would have saved us fifty-six hours in the water.

"It was about that time that the engineer informed me we had but two hours of gasoline and I decided to descend to the sea."

"Then you were not forced down by the storm or fog?" he was asked.

"Not at all," replied the commander after a slight pause. "The plane—all of them, in fact—could have withstood the storm and fog nicely. We came down because we didn't know where we were, and could not afford to take chances with so limited a supply of gas."

"But you were supposed to know by means of your radio compass."

The commander paused for a considerable time.

"I'll be perfectly frank with you," he said finally. "That was the whole trouble—not the fog and unexpected storm. But I want to say right here that the most valuable result of the flight, scientifically speaking, was the demonstration that the radio compass is most remarkable. It will make air travel over the ocean feasible.

"The difficulty did not lay in the fact that the compass was imperfect, but in the fact that under the system of installation on the planes it was confined to a radius of ten miles. With proper installation it would have recorded signals sent from a distance of 150 miles. We knew the limitations before we got to Halifax. We also were aware that it would require at least a week to make the necessary changes.

An unconventional portrait of the unfortunate Commander Grieve, in the safety suit which he wore when rescued. It will be recalled that, after being saved with Hawker, he remarked: "The future of navigation of the air undoubtedly lies with directional wireless"

"We discussed the matter and decided that in view of the favorable weather reports we were not taking much of a chance in starting with the inefficient radio compass.

"So we started, ran into a storm, and two of us had to come down for the reasons I have given. If we had known just where we were we would have kept right on as we had gas enough for the trip. It was the compass alone which caused two of the three boats to fail."

"There is one impression I wish you would correct," he said. "Our wireless did not give out. We continually sent messages asking for aid after we had come down onto the water, but the ships and shore stations were so industrious asking our position that they couldn't hear us. We couldn't get a word in edgewise."

Getting back to the radio compass, the commander wanted to make it very plain that he advocates it strongly. He repeatedly said it was the greatest discovery yet made in aerial navigation, and as often asserted that with proper installation his would have met all requirements.

Inductively Coupled Transmitter for Extremely Short Wave Lengths

IT appears that a considerable amount of research work on extremely short wave transmitters has been carried on abroad. Many problems are encountered in the design of such sending sets. This will be evident from the following brief review.

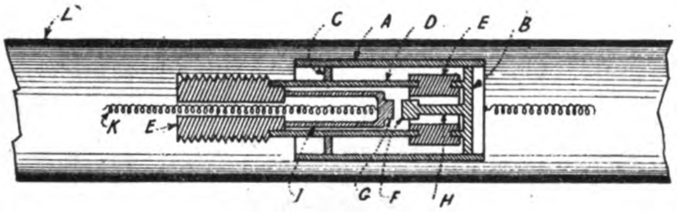


Figure 1.—Longitudinal section of the short wave inductively coupled transmitter

In the well-known Marconi type of coupled circuit transmitters, the primary circuit comprises three elements, (1) a condenser (2) an inductance, and (3) a spark gap. The energy which can be supplied per discharge to such a primary circuit depends upon the capacity of the condenser and the potential to which it can be charged, and therefore to obtain the maximum energy capacity the condenser should be of the greatest capacity possible.

The decrement of the circuit is proportional to the ratio of the high frequency resistance to the inductance. The losses due to the high frequency resistance are (a) losses at the spark gap, (b) losses in the condenser, and (c) losses in the conductors, a large portion of which is caused by eddy currents due to unequal distribution of the magnetic flux in the conductors. Practically these losses cannot be entirely prevented, but they can be greatly reduced by employing special forms of spark gap, air condensers, and a large amount of stranded copper in the conductors.

In order to make the decrement of the circuit sufficiently small, it is essential that the inductance be not too much reduced, and this necessitates that for any particular frequency the condenser shall have more than a certain capacity. For the frequencies usually employed in wireless telegraphy—1,000,000 down to 20,000—it is not difficult to arrange the elements of the primary circuit so as to insure sufficient energy capacity with small decrement, but for frequencies of the order of 100,000,000—three meter wave length—it becomes very difficult to arrange the elements so as to insure a similar result. C. S. Franklin of London has devised a special transmitter in which each of the three elements of such a circuit is arranged symmetrically about a common axis.

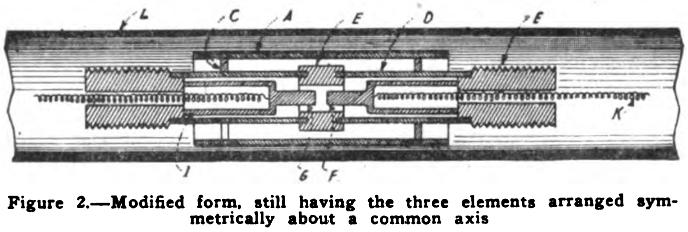


Figure 2.—Modified form, still having the three elements arranged symmetrically about a common axis

Figure 1 is a longitudinal section through the common axis while figures 2 and 3 are similar views of modified forms.

In figure 1, A is a metal cylinder, one end of which is closed by a metal disc B, while the other end is closed by a metal ring C and a co-axial cylinder D mounted between insulating blocks E. The ring C can be slid within the cylinder A for tuning purposes. The cylinder D is filled with gas under pressure. F, G, are the spark electrodes, F being carried on a rod H secured to the center of the disc B, and G being carried by a third cylinder I. K, K, are choking coils through which the condenser formed of the cylinders D, I is charged. The circuit comprises the condenser formed of the cylinders D, I, the spark gap, rod H, disc B, cylinder A and the ring C. The antenna consists of one or more rods L arranged parallel to the common axis of the cylinders and close to the outer surface of the cylinder A, the closeness of the coupling depending upon the proximity of these rods to the cylinder.

In the modification shown in figure 2, there are two cylinders D, D, insulated from each other by blocks E, two rings C, C and two cylinders I, I. The oscillating circuit here comprises the two condensers formed of the cylinders I, D, the spark gap, the rings C, C and the cylinder A.

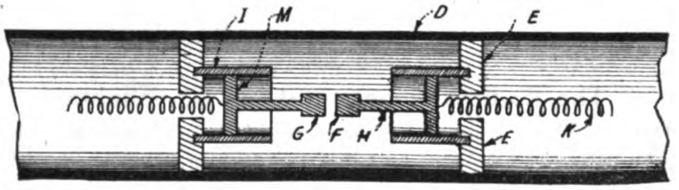


Figure 3.—The simplest construction and the most suitable for short waves

In figure 3, which shows the simplest construction and that most suitable for very short waves, there are a cylinder D, and two cylinders I, in each of which there is a disc M supporting a rod H carrying an electrode, the three cylinders being of course, mounted on a common axis while the cylinder D, acts not only as one plate of the condenser, but also as the antenna.

The high frequency circuit can be traced in each of the three arrangements as follows: In figure 1, it runs from the spark terminal F through the rod H to the disc B, through the coupling cylinder A, to the disc C, to the cylinder D, by condenser action to the cylinder I, to the spark terminal G.

In figure 2, it runs from the spark terminal F, to cylinder I, by condenser action to cylinder D, to the disc C, to the coupling cylinder A, to the second disc C, to the second cylinder D, by condenser action to the second cylinder I, to the spark terminal G.

In figure 3, it runs from the spark terminal F through the rod H to the right disc M, to the right hand cylinder I, by condenser action to the coupling cylinder D, by condenser action from cylinder D to left hand cylinder I, to the disc M and through the left hand rod H to the spark terminal G.

It will be seen that the high frequency oscillations do not pass through any coils at all, the only inductance in the high frequency circuits being that of straight rods and cylinders, and it will be seen that all the parts enumerated are all coaxial with the spark gap.

Artom's Visual Receiver for Directive Wireless Telegraphy

THE detecting device in Artom's system is built somewhat in the form of a d'Arsonval galvanometer. The movable coil is traversed by rectified high frequency currents fed by directive aerials. The coils are disposed vertically and are free to turn around a vertical axis; their angular disposition is similar to that of the vertical planes containing the directive aerials. The coils are disposed as shown in figure 1, one beneath the other; they are rigidly connected and pivoted, or suspended in any other suitable manner.

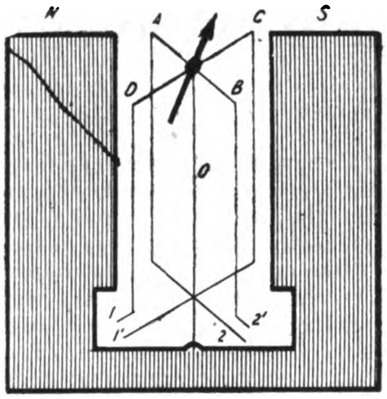


Figure 1

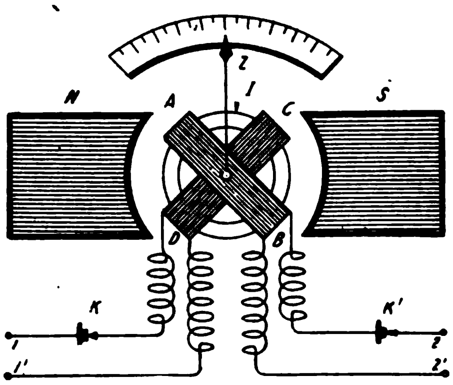


Figure 2

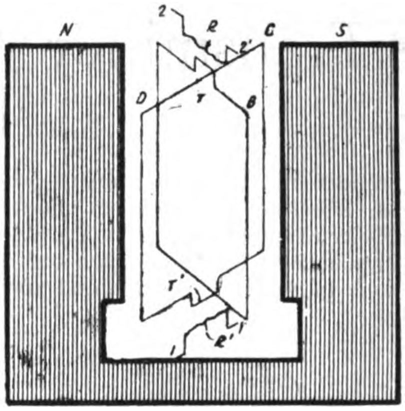


Figure 4

Figures 1 and 2 show the disposition of the meter coils. Figure 4 is a diagram of the thermo-couples

The oscillatory currents induced in the aerial conductors, before traversing the coils flow through the syntonized circuits comprising a detector which may be either of the crystal or of the electrolytic or ionized gas type, or of the magnetic, thermal, or thermo-electric type. They are transformed from oscillatory to rectified currents or to currents having the preponderance of current in one direction.

The coils may be arranged in circuits provided with thermo-couples operated by heaters in the oscillatory circuits, in which case the thermo-couples act as in Boys's micro-radiometer. The coils may be of thin wire like galvanometer coils or may be made with a thicker wire, like ammeter coils. When the rectified currents traverse the coils, magnetic forces are produced by the action of the magnetic field, which cause the movable system formed by the coils to be deflected and such deflection can be shown either by an index or a scale mirror.

The tangent of the angle of deflection depends upon the ratio of the values of the currents traversing the coils, these values being proportional to the currents in the aerial conductors of the receiving station. The deflection depends upon the direction from which the radiating waves arrive. A graduation made once for all shows exactly the direction from which the electric waves arrive, provided the quadrant from which they are transmitted is known.

Figure 1 and figure 2 of the accompanying drawing show diagrammatically the disposition of the galvanometer coils. Figure 3 is a diagrammatic view of the circuit connections of a modified form of the system. Figure 4 is a diagrammatic view illustrating the use of thermo-couples. Here NS is the magnet or electro magnet. AB and CD are the coils which are rigidly connected to each other and which are revoluble on the central axis O. An index Z is attached to the coils. A stationary soft iron cylinder I is disposed in the fields so as to reinforce the action of the magnetic field of the rotating coils.

The detectors or rectifiers of the electric waves are shown by K and K′. The terminals 1, 1′ and 2, 2′ connect the instrument with the directive aerials X and Y.

The constructive forms which the invention may assume in practice are numerous and they vary according to the type of the detector or rectifier of electric waves which are used. The following are the three preferred forms:

(1) In the circuit's movable coils AB and CD two thermo-couples are inserted. Two resistances of manganin or of any other suitable material are traversed by the oscillatory currents coming from the directive aerials. The thermo-couples produce in the coils AB and CD rectified currents which cause the coils to take up a definite position in the stationary magnetic field.

(2) When tubular detectors or rectifiers of the ionized gas type are used, one of the tubes may be provided for each directive aerial. In order to indicate with the greatest accuracy the direction from which the electric waves arrive, the particular form of tube for ionized gas shown in figure 3 can be used with good results. The figure shows a horizontal section of the tube and the circuit connections.

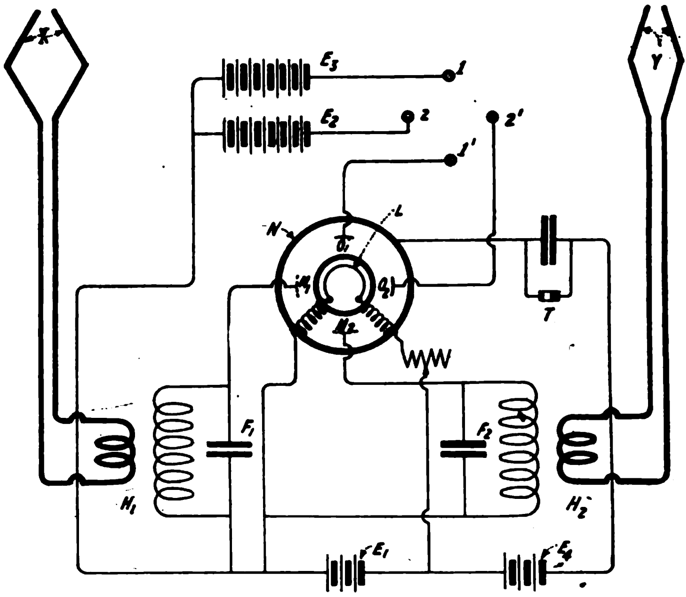


Figure 3.—A horizontal section of the tube and the circuit connections

The incandescent filament L is placed in the central part of a glass tube having a spherical or cylindrical form, provided at the periphery with the cylindrical plate N for the reception of the telephonic signals. M^1 M^2 are metallic grids: O^1 O^2 are metallic plates connected respectively to the leads of 1′ and 2′. The latter are connected to the galvanometer coils as shown in figure 2.

The position of the grids M^1 M^2 relatively to the plates O^1 O^2 and to the filament is not necessarily that shown in the drawing but may be changed to other positions. The battery E^1 is a source of energy for the filament L, the batteries E^2 and E^3 energize the space between the incandescent filament and the conducting plates O^1, O^2, E^4 transmit current across the ionized space between the filament and the cylindrical plate N to energize the circuit of the telephone T. F^1, F^2 are capacities inserted in the oscillatory receiving circuit of which H^1 and H^2 represent the oscillation transformers, that is to say, the primary coils of the transformers H^1 and H^2 are connected at xx-yy to the directive aerials.

(3) When a detector of the electrolytic type is used, a single vessel containing acidulated water or other suitable liquid may be employed wherein the electrodes for both or all the detectors are immersed.

In figure 4, there is shown diagrammatically the arrangement of the thermo-couples. In this figure NS is the magnet, AB and CD are the galvanometer coils, T and T′ are the thermo-couples and R R′ are thin strips of gold leaf or manganin which are connected with the directive aerials and act as heater elements.

A Transmitter Designed to Radiate Waves of Low Decrement

To render the receiving apparatus of a radio system most effective, the impulses impressed upon the receiving circuit should occur at the rate of approximately 1000 impulses per second, which corresponds to the frequency or pitch of a tone of good audibility. To insure uniformity in the production of the tone in the receiving circuit and also the production of a note having a constant pitch, these impulses should be produced at regular as well as frequent, intervals. Moreover, the loudness of the tone produced in the receiving circuit depends upon the amplitudes of the impinging wave trains. This last property is secured over long distances by generating wave trains at the sending station that are only slightly damped or possess a low decrement. It is apparent, therefore, that the wave trains originating in the sending station should be produced at regular intervals and with suitable frequency, as well as with high initial amplitudes, in order to radiate from the antenna a series of wave trains that may be projected over wide spaces and be instrumental in producing in the receiving apparatus audible notes of constant pitch or uniformity.

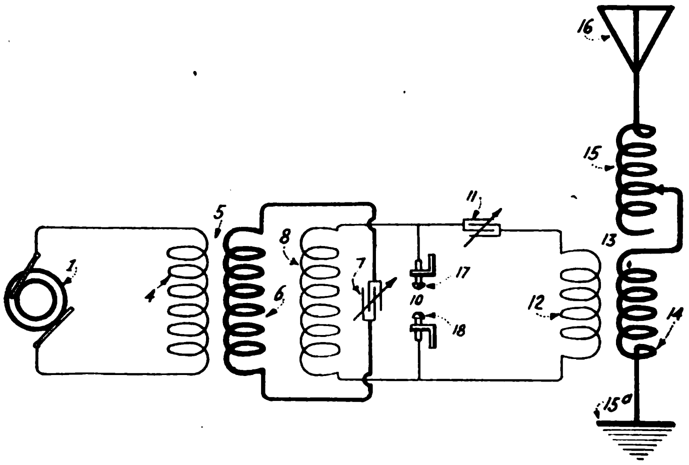


Figure 1.—Diagram of transmitter for generating slightly damped waves

C. L. G. Fortescue claims that the transmitter shown in the accompanying drawings generates waves that are only slightly damped. At the same time, the wave trains projected into space may be produced at a high rate and uniform frequency in order to insure the production of a uniformly pitched and audible note in a distant receiving station.

In figure 1, a source 1 of alternating current is connected by conductors 2 and 3, to a primary winding 4 of a transformer 5. One secondary winding 6 of the transformer is connected in a closed circuit with an adjustable condenser 7. The windings 4 and 6 of the transformer are magnetically linked closely with each other. The capacity of the condenser 7 is so chosen that its effect in the circuit comprising the primary winding 4, will under certain circumstances, completely compensate for the inductive reactive drop in the circuit when subjected to the flow of alternating currents having the frequency of those generated by the source 1. In other words, the circuit comprising the primary winding 4 may operate, in certain instances, at unity power-factor since the condenser 7 will completely compensate for the inductive reactance created therein.

A secondary winding 8 of the transformer energizes the high frequency oscillating circuit 9, which comprises a spark gap 10, an adjustable condenser 11 and a primary winding 12, of an oscillation transformer 13. A secondary winding 14 of the oscillation transformer has one of its terminals grounded at 15 and the other connected, through an adjustable inductance 15, to the antenna or electrical wave radiator 16. The windings 8 and 4 of the transformer 5 are magnetically linked loosely with each other and, therefore, a leakage flux will obtain between the primary or inducing winding 4 and the secondary winding, under certain operating conditions.

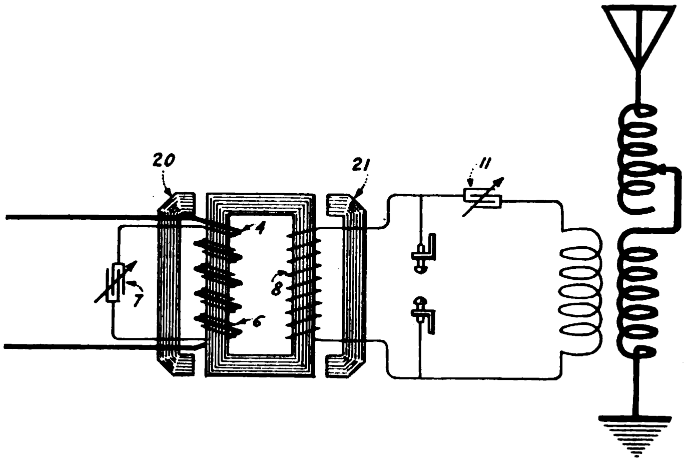


Figure 2.—The structure for obtaining the desired relations of the transformer windings

Again, if proper quenching of the sparks generated by the oscillation producer 10 is effected, the oscillations in the circuit comprising the primary winding 12 will discontinue after a very short time interval. The secondary circuit, therefore, will continue to oscillate at its natural frequency and with its natural damping just as if the primary circuit did not exist.

The capacity of the condenser 11 is so chosen that the circuit comprising the secondary winding 8 and the primary winding 12 of the oscillation transformer is in resonance with the circuit comprising the primary winding 4 of the transformer 5, when the oscillation producer 10 is inactive. In other words, series resonance conditions are established between these two circuits, since the condenser 11 inserts a condensive reactance that resonates with the inductive reactance inserted by reason of the leakage flux obtaining between the windings 4 and 8.

The condenser 7, by reason of its association with the winding 6, compensates for the inductance obtaining in the circuit of the primary winding 4 only when the spark gap 10 is active. As a result, the maximum flux threading through the primary winding 4 occurs with the maximum voltage or the peak of the alternating current wave generated by the alternator 1, when the condenser 11 is rapidly charging and discharging through the gap 10.

When the voltage in the secondary winding 8 is sufficient to break down the spark gap 10, the condenser 11 will discharge through the gap, thereby generating high frequency oscillations in the oscillating circuit 9. Simultaneously therewith, the secondary winding 8 will be short circuited by the gap. At the same time the circuit comprising the primary winding 4 will operate at unity power factor by reason of the action of the condenser 7. The value of the flux generated by the primary 4 is, therefore, independent of the conditions obtaining in the high frequency oscillating circuit 9.

When these conditions exist, the voltage induced in the secondary winding 8 is likewise coincident in time with the magnetic flux generated by the primary winding 4, because the circuit comprising the short circuited secondary winding 8 is in resonance with the circuit comprising the primary winding 4. In other words, this combination of circuits is tuned to the frequency of the source of supply 1.

In figure 2, there is shown diagrammatically, a structure for obtaining the desired relations between the windings 4, 6 and 8 of the transformer 5 of figure 1. It will be noted that the primary winding 4 is disposed on the same core leg as the secondary winding 6. The windings 4 and 6 are, therefore, closely linked magnetically with each other. The secondary winding 8 is disposed on a second core leg. Magnetic shunts 20 and 21 provide means for increasing or varying the magnetic leakage between the primary winding 4 and the secondary winding 8. By properly positioning the magnetic shunts 20 and 21, series resonance may be established between the winding 4 and the winding 8 in combination with the condenser reactance element 11.

Methods of Signaling with Arc Transmitters

SIGNALING with arc transmitters has heretofore usually been effected by varying the wave length of the radiated wave. This has been done by short circuiting a portion of the inductance, but in high powered stations the current in the short circuit is large, which makes it a difficult problem. Leonard Fuller has recently shown another method in which there is provided an oscillatory circuit, figure 1, containing an inductance 9 and a capacity 12 and an energy consuming reactance which is controllable to vary the losses occurring therein. This circuit is shunted around the source of oscillations or arc 2.

When an arc is shunted by two dissimilar oscillatory circuits, it will oscillate upon one circuit or the other, but will not oscillate upon both at the same time. It will in fact oscillate upon the circuit most agreeable to arc conditions, to the total neglect of the other. By varying the reactance of the shunt circuit, this circuit is chosen or neglected by the oscillations, and consequently the radiating circuit is either neglected or chosen according to the manipulations of the key.

The energy consuming element comprises a core 14 formed of stiff iron laminations, which are chosen to provide a large hysteresis loss, especially at high frequencies. A coil 15, forming part of the shunt oscillatory circuit, is wound on a portion of the core. The current in the coil produces a flux in the core, which causes a loss of energy due to hysteresis. By reducing the hysteresis the losses are reduced, so that the oscillations will prefer the shunt circuit to the neglect of the radiating circuit. This loss may be reduced by subjecting the iron core to a M.M.F. produced by a direct current coil 16, which is wound on a portion of the core and arranged in circuit with the battery 17. A key 18 arranged in the battery circuit provides means for opening and closing such a circuit.

Choke coils 19 are preferably arranged between the battery and the coil 16 to prevent the high frequency current generated in the coil from passing into the battery. Other means to accomplish this result may also be used. The size of the coil and battery are preferably such that when the key is closed, the core is saturated, thereby reducing the hysteresis and hence the losses in the shunt circuit. Due to the losses, the core becomes heated and in order to dissipate the heat, the core is immersed in an oil bath 21 through which pipes 22 carrying cooling water pass.

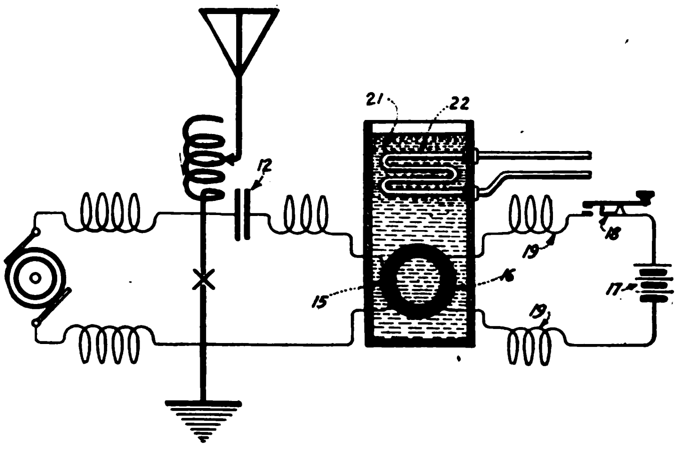
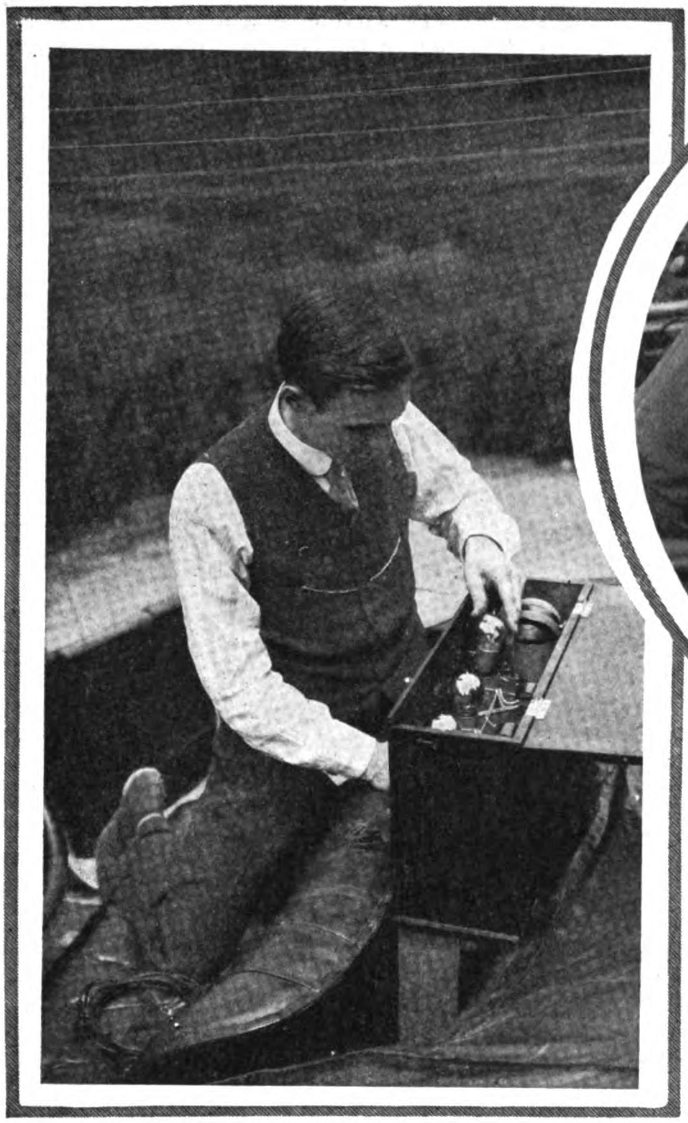


Figure 1.—An oscillating circuit containing an inductance, a capacity and a reactance shunted around the arc; used in Fuller's method of signaling with arc transmitters

Signaling is accomplished by opening and closing the key 18; closing the D.C. circuit serves to reduce the hysteresis and hence the losses in the shunt circuit, thereby causing the arc to oscillate upon that circuit to the neglect of the radiating circuit and opening the D.C. circuit, causing an increase in the losses in the shunt circuit and thereby causing the arc to oscillate in the radiating circuit.



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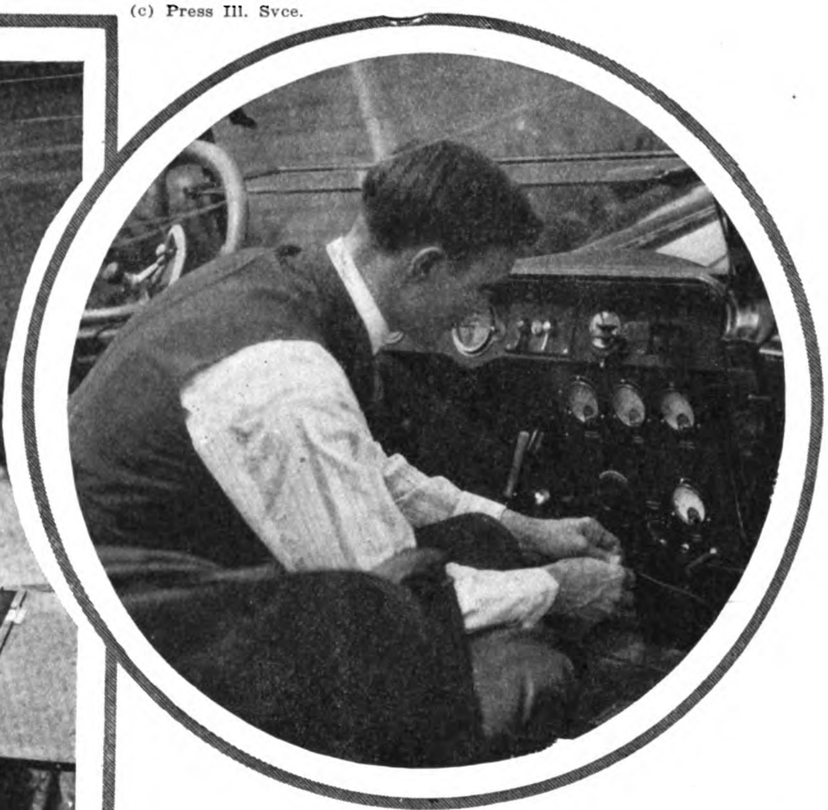
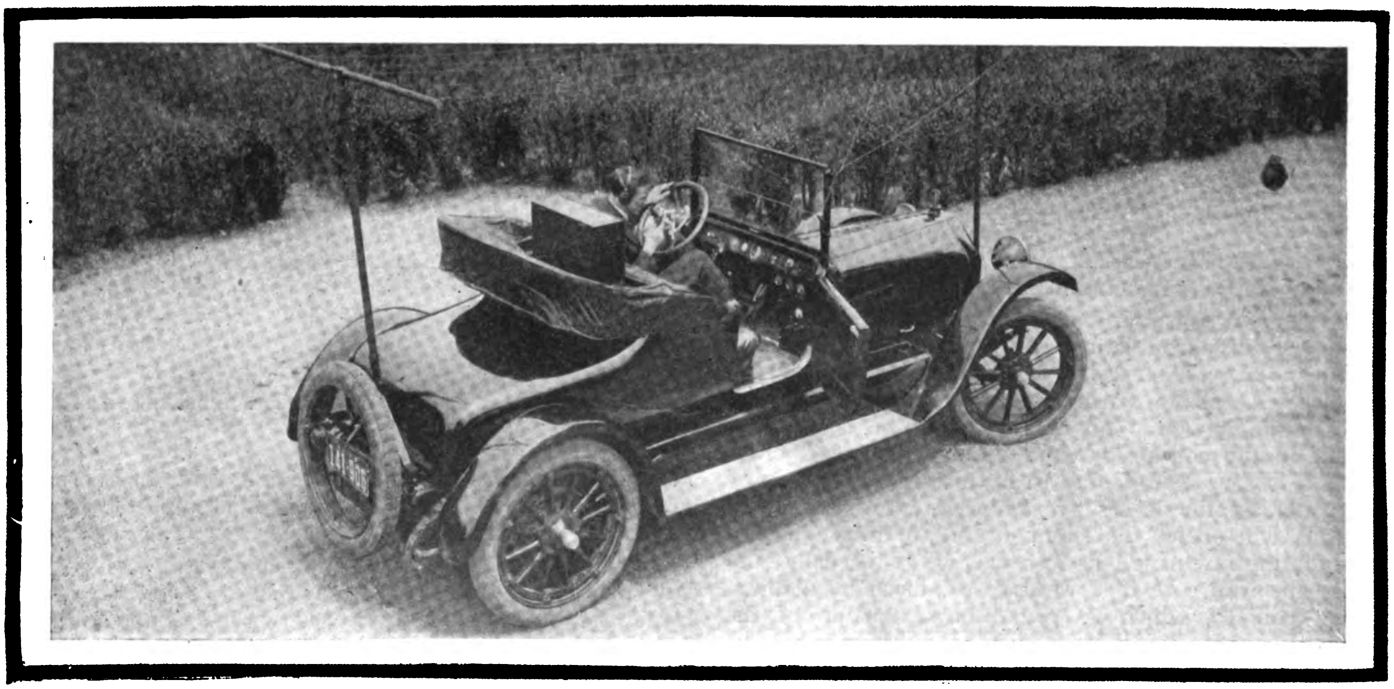


Wireless On Wheels

The radio telephone has been successfully used on airplanes and small craft, but the adaptation to the automobile is novel and presents a field for future possibilities

The radiophone equipment shown above is capable of keeping in telephone communication with another station for a distance of from 15 to 20 miles and with its emergency radio telegraph it can communicate as far as forty miles

The transmitting apparatus (on the left) is of the latest type, employing vacuum tubes as generators of radio energy, while the receiver is a highly developed device with enclosed regenerative circuits and amplifiers which enable communication to be maintained long after the signals become too weak to be heard without these new devices



The antenna equipment is compact and may be slung under the running board on hooks provided for that purpose. In the photo it is shown above the running board as it cannot be seen very well when it is in the proper position under the running board

A Summer on the Great Lakes

The Second of a Series of Impressions of a Novice in Commercial Wireless Operating

By Julian K. Henney

II—Such Is Life

"WHAT a wonderful thing wireless is! I simply don't see how it works."

Every time some talkative passenger came to the radio room of the Juniata that summer, and started the usual line about how interesting and wonderful is wireless, I thought of that first night and the day following. And as I sat there on the stool that had been Jones' undoing, I thought too, how wonderful — and fearful — the new art of radio communication had been.

Snell won the first watch by the toss of a penny and I turned in. At two o'clock he awoke me to finish the night, or to stand by until relieved, should our friend come to.

When I turned out of the warm bunk and bundled up in more clothes, I noticed at once that the waters had calmed a bit, although the wind was still whistling in the rigging above us and the four huge stacks were booming away in an awesome manner. There was still quite a bit of roll and the chairs were trying their best not to get dizzy and fall under the table. As I climbed to the high stool, the pinnacle from which Jones had ignominiously fallen, I mentally prayed that I might be spared a similar fate.

I saw at once that it was no wonder that seasickness had overtaken the wireless man of the Seeandbee. That stool was about the worst thing imaginable that one could be perched upon in a gale. Like the old three-legged milking stool that used to grace every cow shed in farmland, it simply would not stand still. With every lurch of the ship—they came less frequently now, thank Heaven —I threw out my hand to keep from falling against the opposite wall; both feet went out in the same direction, too, on those occasions when I was able to get them untangled from the rungs of the blooming stool. The receivers clung to my ears tightly and only served to accentuate the dull roaring outside and the groan of the stacks above. That morning watch promised to be anything but delightful.

Signals soon came in, however, and they served to distract my attention from the swaying of my seat. They were the first I had heard since my amateur station had been closed because of the war emergency, so I was all eagerness to hear them again. First came a few buzzes in familiar tone. It was like hearing from an old friend, for the station sending was a D. & C. boat plying between Toledo and Mackinac, on which I had once served as operator. Next came a coarse resonant rumble from far away Calumet. That these signals should be received, clear down in Lake Erie, was a surprise to me, but when Cape Hatteras started coming in with his old high-pitched, earsplitting racket, I began to realize the effectiveness of the tall masts of the Seeandbee. Several other stations were picked up—one sending out submarine warnings, another talking in code—and then, just before Jones relieved me, I made the acquaintance of Snell's friend Dietsch of the Detroit Third. He called to say good morning and to ask if we had any business for him. I came back with a good strong "nothing doing" and a good morning, and turned around to see Jones staring. We had a little friendly confab and he apologized for robbing us of our sleep, before I turned in. It was five o'clock by my watch, and at eight we would be in port!

From the very start of that first day we began to realize how interesting wireless could be. We lugged our cargo of freight—the hand trunk of mine; the suitcase with a lifetime outfit in it; the mandolin; the straw hat and Snell's kodak—down three flights of stairs and across the gangplank. At the end of the plank a sleepy-eyed officer took our blue passes and cursed us heartily because we laughed at him. He looked as if he had put in a wild night of it, and when we smiled he hastened to explain that he had been up with a sick passenger. This of course amused us still more so instead of only smiling, we laughed outright. Thereupon the officer invited us to ride to a place much warmer than the Seeandbee on a stormy night. The reception committee appeared to be constructively, on the job. Our friend of the sardine sandwich and the ginger ale, looking as though he were the sick passenger, then came out and he joined the assistant purser in his malediction.

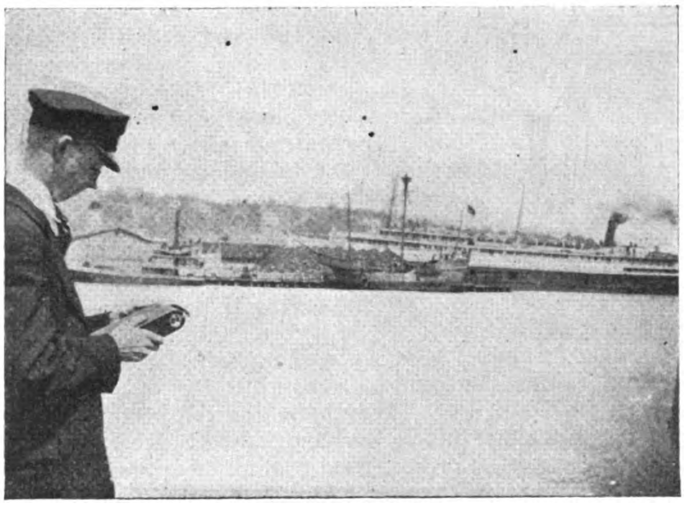
We figured that we could lug our stuff to the Juniata, get it stowed away, see that things were shipshape, and then hike to town for something to eat. We needed it; neither of us had had a thing to eat except the shredded wheat of the night before.

The newly painted funnel of the vessel that was to be our home for the summer, loomed up through the early morning mist and fog, astern of the Seeandbee, and the ship looked mighty good to us after the experiences of the night we had spent on the sidewheeler. Three masts and the brightly shining red copper wire of a new aerial beckoned to us across Buffalo's alleged river as we gazed upon the white and spotless decks and the green waterline of the Juniata. It was to be our home for a good many days after that, and there were to be times when we would give most anything to be able to get off for a few days and sleep in a real bed that did not shake and tremble all night long. But at the present time we were full of youthful enthusiasm, full of spirit that seemed indomitable; as full of curiosity as if we were to play with a new toy for the first time. The red smoke stack and the pure white steam rising from behind it invited us to hurry aboard and get acquainted.

As the sun began to penetrate the mist which is common to lake ports in the early morning, we walked across the bridge to where the Juniata was tied up alongside an old warehouse. My traveling bag was heavy—have I emphasized that fact before?—without anything in it, its weight was enough to stagger a man. I had stocked it for a three months' stay. Snell was burdened with three times as much stuff. We were somewhat warm when we arrived at the warehouse.

I wondered at the time what in the world Watson could have in his suitcase. Had he brought a private wireless outfit of his own or only a few hundred pounds of sugar for his personal use during the summer? I found out later I had overestimated the capacity of that heavy affair. It only held two suits of clothes, a uniform, a half dozen pairs of shoes, a library of seven or eight volumes, several portfolios of mandolin music, an innumerable number of films, all of the usual run of heavy clothing that mothers continually load on disgusted sons, and several reams of letter paper. In one small suitcase! There certainly was reason for Snell's belabored breathing on that muggy July morning.

So we lugged and lugged, and lugged some more. At about every third step, one of us would give out and stop for breath. Watson would change the kodak to the left hand, pick up the wardrobe with the right, and leave the mandolin on the ground. He would look disgusted with the world in general, mop his face, and valiantly start off again. Then he would come out with the kodak on the ground. Finally, to expedite matters a little, I grabbed the kodak and led the pilgrimage through the hot sun that fairly roasted us as it beamed down and reflected sizzlingly from the dusty tracks along which we were walking.


Evidence of the existence of the troublesome kodak that marred the early pleasures of two enthusiastic wireless operators

At the entrance to the warehouse an old bewhiskered gentleman wearing a policeman's club demanded our passes. Here was a chance to exhibit prideful possession of new water-front passes. Now, there are passes and passes. Ours were issued at Cleveland and they were supposed to be good at any water-front of the United States. It said so plainly on the front of the little cards we handed the guard. Other embellishments consisted of our photographs, pasted on the face of the pass, with very interesting and useful information concerning the land of our nativity, our present whereabouts, our domestic state, and many other things. All of these intimate details appeared unimpressive to the guard.

As we flashed the cards into the old gentleman's view, it became evident that they were new ones on him. After the first squint, off came his spectacles, to be polished with the most aged and worn bandana I had ever seen. Then he caught sight of the pictures. He pulled his long white chin whiskers and tried to reconcile the photo with my moist and exasperated countenance; the sun grew warmer and warmer.

"Now see here young man," punctuating his remarks with swishing expectorations of Navy plug, "this here card's . . . no good to me. If'n you fellers expect. . . get in here. . . got to go to the office. . . get passes. Do you see? Passes is what you got to have. . . get in here. Yes sir, that's what you lads need if . . . want to get on the Juniata."

So we had to convince the old fossil that those pretty picture cards were passes. Our tempers were pretty far gone when he finally let us enter the warehouse, pointing out the hole in the door through which we could get to the steamer.

We hastened across the long building, winding our way among piles of flour that rose to the ceiling, stacks of bright copper ingots, bales of binder twine in sufficient quantity to tie up the universe, and huge packing cases in an innumerable number. Most of them looked fully as heavy as Snell's suitcase, and at least one—a case for a grand piano—faintly resembled my own outfit.

Arrived at the opening in the door he stopped to draw breath before going through to the river. Then we gathered up the luggage once more, for the last time, we firmly resolved. I took the mandolin and my traveling bag and Watson carried the rest of the paraphernalia. We pulled ourselves through the hole and saw—not the Juniata firmly tied up to the dock, but gracefully moving out in midstream on her way to the passenger docks. We were too late!

It was too much for overweighted nerves. Watchman, warehouse, Seeandbee, luck in general, individually and collectively, were made the recipients of the best of our American vocabulary. My grievances were expressed on general principles; Snell's because he knew it was a full half-mile from the warehouse slip to the Lackawanna pier where the Juniata would stop to take on passengers. This meant a half mile walk in the sun, back over those hot and dusty tracks—and a half mile more, after we had arrived at our starting place. I, of course, didn't know these details.

We sat down on a stevedore's truck and said various things about the weather and affiliated factors. Youth, however, is invincible; the funny side of it all soon became apparent. Laughter refreshed our minds. We knew that we were up against it, and it was best to be happy; to think of the good dinner we were soon to get.

It was then ten o'clock; by ten-thirty we had tramped back to the bridge over which we had just traversed; our passes had been viséd several times all over again. The walk was one to be remembered but not discussed.

You can easily see that we were about the happiest youngsters that ever boarded ship when we walked the gangplank of the Juniata that second day of July and started up the long and circuitous path that led to the radio room.

Our happiness was short lived, however. Scarcely had we crossed the plank when we were stopped by a man, tall and lean, complacently picking his teeth as though he had just had a full dinner. It was the captain. Introducing ourselves with our neat and well written letters from the Superintendent of the Marconi Company we asked the skipper if he had anything in particular for us to do beside getting ourselves acquainted with the radio equipment. Captain Jones was new at running ships with wireless attached to them, so he merely grunted, waved his hand and said he would see us again. He did . . . lots!

We disappeared up the companionway toward the radio cabin. Snell led the way, announcing that since he had been on board the Juniata for several months the previous summer, he was on to the curves of the ship. He disappeared with a rush up the steps, but those three narrow and steep flights, seemed like fourteen to me. By the time I had dragged my traveling bag and the kodak up to the aft saloon deck, I was nearly ready to fall over the rail.

But our troubles had barely started!

The equipment had been installed a few days before by the Marconi construction man, and it was our manifest duty to see that the stuff worked before the ship left port.

The first thing we noticed was the new paint. It was on everything, table, walls . . . apparatus, daubed on in generous fashion. It was not dry, and the plentiful supply on our coats required first attention. Snell was rather precipitous. He had sat down in the disconsolate looking chair that stared bravely through its new paints at us. Gracefully, and most confidently, he leaned back, all unconscious that he had wiped off half the white paint on his coat. Then he duplicated the result by putting his arms on the operating table in the same manner that we later found Bill—the second mate—eating. Friend Snell's disposition was not thereby improved.

I sat down, carefully, and with due respect for the fresh whiteness, hardly expecting to escape entirely. I pressed the key; the transmitter uttered a roar that brought me hard up against the wall—and more paint. But it was definitely established that the sender worked, and judging from the noise, we decided that it worked to perfection. But when we put on the receivers there was "nobody t' hum", as the Third Engineer might have remarked. We jiggled and juggled, changed all sorts of adjustments and traced wires, but still nothing but silence rewarded us. The navy station at Buffalo was in sight; so were several steamers, but not a scratch came into the receivers. Until a signal should be caught there was not the slightest excuse to leave for town and dinner. After two hours of alternate listening and adjusting we decided that something was wrong with the outfit.

"Maybe it's the phones," said Snell.

So I dumped the luggage out of my grip and dug up my head receivers. Watson tried them, held up his hand as if to say, "Sh, there's something doing." But it was a false alarm; in a few minutes his expression changed; by his face I knew the somebody had not as yet returned home.

It was then nearly noon, and still not a buzz had been heard. The trouble was clearly in the tuner, but one look into the maze of wires dismayed us. We turned to the connections, the explanations of which required dumping my stuff on the deck, in full view of the admiring members of the crew, so we could find a book containing circuit diagrams. This helped us to understand the puzzle and at twelve-thirty we were satisfied that everything was all right with the tuner circuit. Finally, we carted the whole works up to the top deck in an endeavor to get a good ground connection to the copper indicators. Still nothing doing.

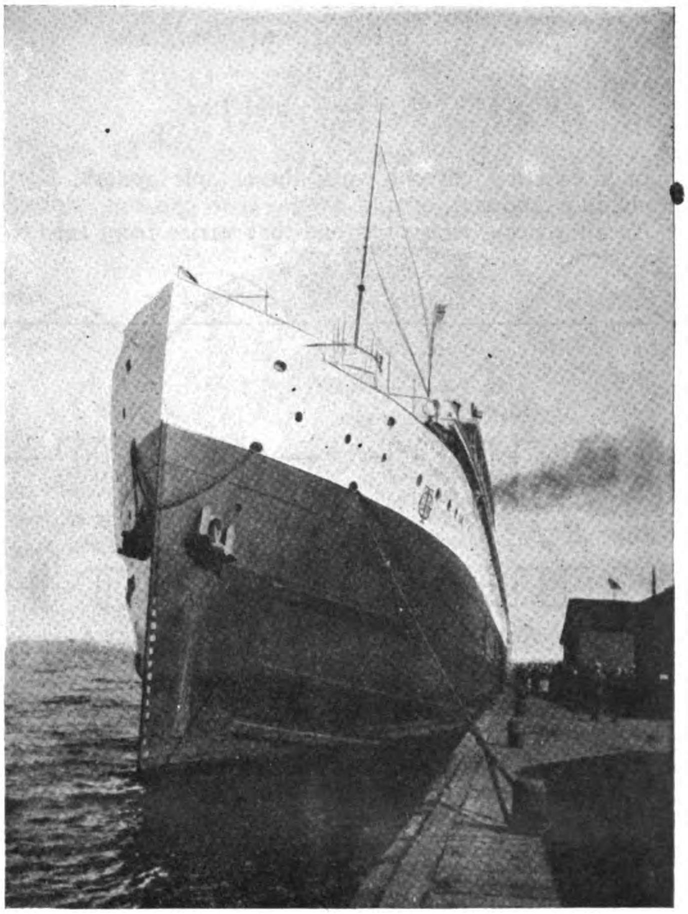
Fragmentary advice, muttered sections of virile vocabulary repeated in toto, spurred on by pangs of hunger and desperation, floated off the aft deck into the thick waters of Buffalo, but nary a splash of signals echoed in the receivers. About noon—that, is about one o'clock Buffalo time—the chef called us to the Officers' Mess and placed before us a couple of egg sandwiches. He was a wonderful chef. After devouring his offering we felt decidedly better and renewed our quest of the unknown with added zest.

At two o'clock, when we were still searching for trouble, several tugs puffed past towing the Tionesta—a sister ship of the Juniata—to the warehouse. As she was slowly maneuvered past us by the puffing tugs, I noticed the aerial wires came down to her deck in the same manner as our own, and as I thought of her equipment an idea came to mind. Why not exchange apparatus with the Tionesta? She was not due to sail for several days; the office would have plenty of time to get a new tuner to the vessel, and no one would be out. If worse came to worse, we would have a good outfit anyway and we could let the other operators worry.

As soon as the newly painted Tionesta was warped into her slip we hastened aboard. The construction man had taken the receivers with him, so we were compelled to disconnect the receiving cabinet and take it to our own ship to try it out. On the way back to the Juniata we had decided to merely exchange tuners and say nothing about it.

With the equipment tucked under our arms we ran for our steamer. It was then nearly three o'clock; we sailed at four. By a quarter after three everything was ready, wires connected again, receivers tested and batteries hooked up Snell sat in front of the outfit with a "Lord help us" expression on his face. Passengers were beginning to come aboard, and about everyone of them stopped at our cabin door on their way around the boat. The crew was below decks, much to our satisfaction. It was a tense moment. We would have to give up if the thing did not work at that late hour.

Fifteen minutes later the suspense ended. Strong signals were heard and we were at last free to sigh in relief and to take a look around us. It was then too late to go back to the Tionesta with the bum tuner, so we decided to carry them both until further orders.



The brightly shining copper wire of a new aerial on the vessel that was to be our home for the summer loomed up through the early morning mist and fog

At four we left for Cleveland on the first trip of the season, with a fair passenger list; at five we had a regular meal in the officers' mess, and at seven we sent our first message to the Marconi offices, announcing that we had "hooked" the Tionesta's tuner and that she had none at all. We fully expected to find two new operators at Cleveland waiting to take our jobs.

Without incident, the hours drew round to midnight when I came on duty fairly bristling with efficiency, after six hours of sleep. I looked about. The old box of a tuner lay in the corner of the cabin to which it had been relegated. The purloined one on the table registering every scratch of static and signal. Thoughtfully, I looked from one to the other, reflecting on the universal comment of passengers:

"What a wonderful thing wireless is. I simply don't see how it works!"

EXPERIMENTERS' WORLD

Views of readers on subjects and specific problems they would like to have discussed in this department will be appreciated by the Editor

Resonance in the Audio Frequency Circuits of Amateur Radio Transmitters

By John J. Holahan

IN considering the effects of resonance in the audio frequency circuits of the radio transmitter, it is well to review briefly the theory of alternating currents. In direct current work the relations between electromotive force (volts), resistance (ohms), current (amperes) and power (watts), are given by the following formulae.

$$W = EI; \quad I = \frac{W}{E}; \quad E = \frac{W}{I}; \quad W = I^2 R;$$

$$E = IR; \quad R = \frac{E}{I}; \text{ and } I = \frac{E}{R}$$

In alternating current work these same general laws apply, in a modified form.

An alternating current is one that varies from zero to maximum to zero in one direction; then reverses, rises to maximum, then falls back to zero. This is called one complete cycle, and takes a certain period of time, which can be represented by the graph, figure 1. This is a sine wave such as is sought after in general commercial work. It also represents the wave form of sustained wave transmitters.

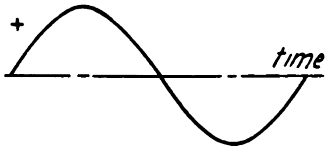


Figure 1

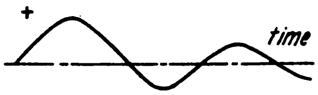


Figure 2

Figure 3

Figure 4

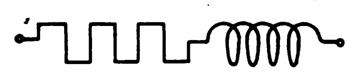


Figure 5

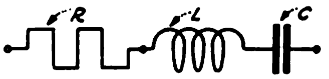


Figure 6

Symbols used to represent alternating current, damped waves, resistance, inductance, and their combinations in series

A damped wave is one that reverses in direction but changes in amplitude. It is represented by figure 2.

The period of an alternating current is the time it takes the current to pass through one set of positive and negative values. Frequency is expressed in cycles per second. The period of the current is $f = \frac{1}{T}$, where T is the time of one cycle expressed in fractions of a second. Thus, the period of a 500 cycle current is 1/500 second.

The instantaneous value of an alternating current is the value of the current at any instant. The maximum value of such a current is the greatest instantaneous value during any cycle. The average value is equal to $I_a = \frac{2}{\pi} I_{max}$.

The effective, or root mean square (RMS) value is the value usually spoken of in AC work, and is that indicated by AC ammeters and voltmeters. It is the square root of the mean of the squares of the instantaneous values of an AC current over a complete cycle.

The effective value $I_{eff} = \frac{I_{max}}{\sqrt{2}}$

As an illustration, if the effective primary voltage of a transformer is 110 volts, then the maximum value is $110 \times \sqrt{2} = 155.5$; the average value is $155.5 \times \frac{2}{\pi} = 99$ volts. Effective values are used in this article.

All radio circuits contain resistance, inductance and capacity, connected up in various ways. Figure 3 indicates a simple resistance. In this case the current is represented by $I = E/R$.

Inductance is indicated by figure 4. It should be stated that any coil that has inductance has resistance also, but it is well to consider them separately, as they have different effects. The equivalent circuit is shown in figure 5. For this circuit the relations between E.M.F. current, resistance and inductance is given by

$$I = \frac{E}{\sqrt{R^2 + (\omega L)^2}} \qquad E = I\sqrt{R^2 + (\omega L)^2}$$

In the above $\omega = 2\pi f$, where f is the frequency in cycles per second. The factor ω is called the periodicity factor of the circuit. R is the resistance, E the voltage, I the current and L the inductance in henries. If this circuit could be made up to contain inductance only and no resistance, the relation would be,

$$I = \frac{E}{\omega L} \qquad E = I\omega L$$

The equivalent circuit for resistance, inductance, and capacity, in series is shown in figure 6.

In this case,

$$I = \frac{E}{\sqrt{R^2 + \left(\omega L - \frac{1}{\omega C}\right)^2}}$$

$$\text{and } E = I\sqrt{R^2 + \left(\omega L - \frac{1}{\omega C}\right)^2}$$

The term $\left(\omega L - \frac{1}{\omega C}\right)$ is called the reactance of the circuit. The term ωL is called the inductive reactance, and the term $\frac{1}{\omega C}$ is called the capacitive reactance. Inductive reactance is always positive, and capacitive reactance is always negative. Sometimes reactance is expressed by the letter X then,

$$I = \frac{E}{\sqrt{R^2 + X^2}} \qquad E = I\sqrt{R^2 + X^2}$$

The factor $\sqrt{R^2 + X^2}$ is called the impedance of the circuit. Resistance, reactance, and impedance are expressed in ohms.

The reactance of a circuit may be positive or negative accordingly as ωL is greater or less than $\frac{1}{\omega C}$. When the reactance is positive ωL is greater than $\frac{1}{\omega C}$ and the current lags behind the E.M.F. in phase. When the reactance is negative $\frac{1}{\omega C}$ is greater than ωL and the current is ahead of the E.M.F. in phase.

The equivalent circuit for resistance, inductance, and capacity in parallel is shown in figure 7.

In this case,

$$I = E\sqrt{\left(\frac{1}{R}\right)^2 + \left(\omega C - \frac{1}{\omega L}\right)^2}$$

and

$$E = \frac{I}{\sqrt{\left(\frac{1}{R}\right)^2 + \left(\omega C - \frac{1}{\omega L}\right)^2}}$$

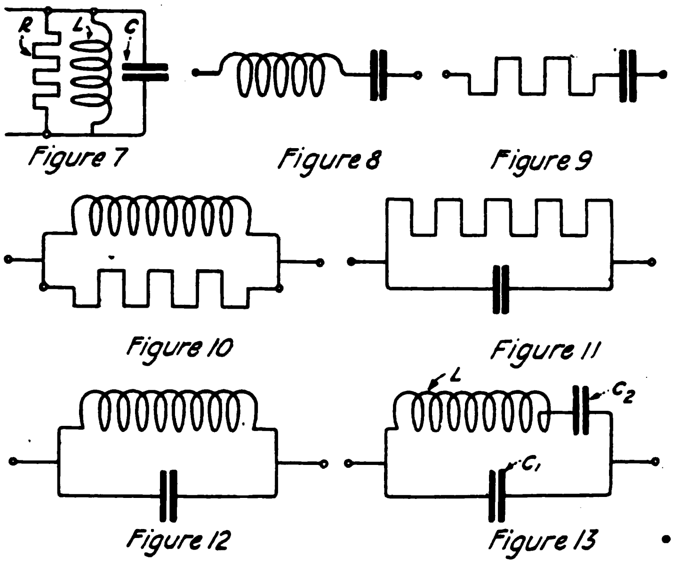


Figure 7 Figure 8 Figure 9

Figure 10 Figure 11

Figure 12 Figure 13

Various circuits showing resistance, inductance and capacity connected in series and parallel

For a circuit with capacity only,

$$I = E\,\omega C \text{ and } E = \frac{I}{\omega C}$$

An inductance and capacity in series are shown in figure 8. Then,

$$I = \frac{E}{\omega L - \frac{1}{\omega C}} \text{ and } E = I\left(\omega L - \frac{1}{\omega C}\right)$$

For a resistance and a capacity in series as in figure 9.

$$I = \frac{E}{\sqrt{R^2 + \left(\frac{1}{\omega C}\right)^2}}$$

also

$$E = I\sqrt{R^2 + \left(\frac{1}{\omega C}\right)^2}$$

For a resistance and inductance, in parallel as in figure 10,

$$I = E\sqrt{\left(\frac{1}{R}\right)^2 + \left(\frac{1}{\omega L}\right)^2}$$

also

$$E = \frac{I}{\sqrt{\left(\frac{1}{R}\right)^2 + \left(\frac{1}{\omega L}\right)^2}}$$

For a resistance and capacity, in parallel as in figure 11.

$$I = E\sqrt{(\omega C)^2 + \left(\frac{1}{R}\right)^2}$$

also

$$E = \frac{I}{\sqrt{(\omega C)^2 + \left(\frac{1}{R}\right)^2}}$$

For an inductance and capacity in parallel as in figure 12,

$$I = E\left(\omega C - \frac{1}{\omega L}\right)$$

also

$$E = \frac{I}{\omega C - \frac{1}{\omega L}}$$

Figure 13 indicates an inductance and capacity in series, shunted by a capacity in parallel. This is a "dummy" antenna of negligible resistance for which

$$X = \frac{\omega^2 L C - 1}{\omega C_2 + \omega C_1 \ (1 - \omega^2 L C_2)}$$

also

$$I = \frac{E}{X} \text{ and } E = I X$$

RESONANCE

In a radio circuit, containing a resistance, an inductance and a capacity, in series, which is the usual radio circuit, we have seen that,

$$I = \frac{E}{\sqrt{R^2 + \left(\omega L - \frac{1}{\omega C}\right)^2}}$$

Now if we select such values of L and C so that

$$\omega L = \frac{1}{\omega C}. \text{ Then } \omega L - \frac{1}{\omega C} = 0$$

and

$$I = \frac{E}{\sqrt{R^2 + 0^2}}$$

$$I = \frac{E}{R}$$

The current is then limited solely by the resistance.

To explain this more fully, let us take the case of a simple valve which is shown in cross section in figure 14-A. The frictional resistance of the opening represents the resistance of the circuit, i. e., ohms. The pressure on the water corresponds to the E.M.F. of the circuit, and the amount of water that will flow to amperes. Now, if ωL predominates as in figure 14-B, then the opening is smaller and the resistance is higher. If $\frac{1}{\omega C}$ predominates, then we have the condition of figure 14-C; the opening is small and the resistance is still high. But, if $\omega L = \frac{1}{\omega C}$ the openings in the body and spindle of the valve coincide and the amount of water that will then flow is determined solely by the pressure and the frictional resistance of the opening in the pipe.

Critical Frequency

This arises from the condition of resonance. If the resistance of the circuit is constant and we adjust L or C

so that $\omega L - \frac{1}{\omega C} = 0$

then, $\omega L = \frac{1}{\omega C}$ or $\omega^2 = \frac{1}{LC}$ or $\omega = \frac{1}{\sqrt{LC}}$

and since $\omega = 2\pi f$

then $f_c = \frac{1}{2\pi\sqrt{LC}}$

This is true for the usual radio circuit where the value of R is very small. The formula that takes in the value of the resistance R is

$$f = \frac{1}{2\pi}\sqrt{\frac{1}{LC} - \frac{R^2}{4L^2}}$$

If R is small, then $\frac{R}{4L}$ reduces practically to zero and the formula becomes $f = \frac{1}{2\pi\sqrt{LC}}$

It can be shown that for high efficiency in radio sets. that the natural frequency of the transformer secondary and the condenser should be the same as that of the generator. That is, the leakage reactance of the secondary should equal the capacitive reactance of the condenser. The leakage reactance of the secondary can be transferred back to the primary by dividing it by the square of the ratio of transformation. This primary reactance is made up of the leakage reactance of the transformer, the leakage reactance of the generator, and the reactance of the regulating reactance coil if any.

Take as an example, a 1. kw. 500-cycle transformer with a 220-volt primary and an 11,300-volt secondary shunted by 0.008 mfd. condenser; suppose the primary current is 10 amperes: the voltage on condenser,

$$V_{max} = 1000\sqrt{\frac{2 \times W}{\text{spark rate} \times \text{mfd.}}}$$

$$= 1000\sqrt{\frac{2 \times 1000}{1000 \times 0.008}} = 16,000 \text{ volts}$$

and $V_{eff} = \frac{V_{max}}{\sqrt{2}} = \frac{16,000}{1.4} = 11,300$

From the relation $\omega L_2 = \frac{1}{\omega C}$, L_2 should equal $\frac{1}{\omega^2 C}$ when L_2 = leakage reactance referred to the sec.

Operating 12 per cent off resonance for a good spark tone = 500 — (500 × .12) = 440 cycles

$$\frac{1}{\omega^2 C} = \frac{1 \times 10^6}{4\pi^2 \times 440^2 \times .008} = 16.5 \text{ henries}$$

Secondary leakage reactance = $2\pi \times 500 \times 16.5 = 52,800$ ohms.

When the gap is in action and the transformer secondary is practically on short circuit, the current in the secondary $\frac{\text{Sec V}}{\omega L} = \frac{11,300}{51,800} = 0.218$ ampere.

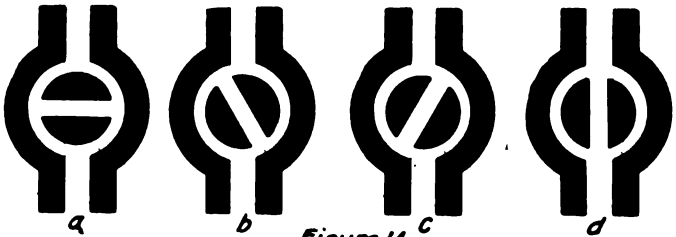


Figure 14

Cross section of a simple valve used to illustrate the relation of resistance, inductance and capacity

When the secondary is charging the condenser with the gap not discharging $1 = \omega C E = 2\pi \times 500 \times 0.008 \times 10^{-6} \times 11,300 = 0.283$ ampere. For working conditions, take the average of these two or 0.25 ampere. This is an approximation.

The ratio of transformation for the conditions outlined above

$$= \frac{\text{Pri I}}{\text{Sec I}} = \frac{10 \text{ amp.}}{0.25 \text{ amp.}} = 40 —$$

Ratio squared = 40 × 40 = 1600 and the total primary inductance $= \frac{16.5}{1,600} = 0.01$ henry. The total primary reactance must equal $2\pi \times 500 \times 0.01 = 31.4$ ohms.

This must be made up of the leakage reactance of the primary, the leakage reactance of the generator, and the reactance of the primary choke.

Methods of finding the leakage reactance of generators will be given in a paper on 500-cycle generator design.

The September Wireless Age Will Contain

the first installment of the story of the Employment of Wireless by the American Expeditionary Force.

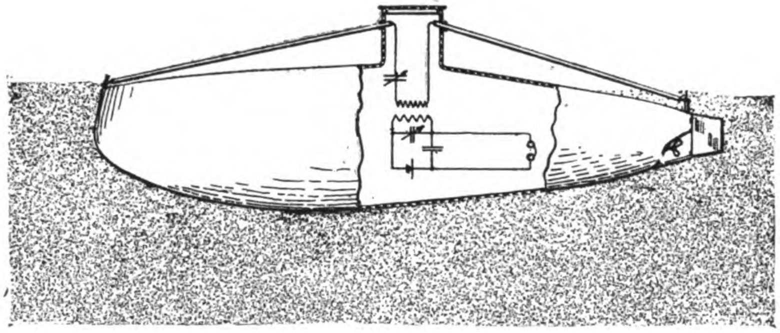
Various types of equipment will be described in detail for the first time. These articles will be profusely illustrated by photographs of apparatus and stations under actual operating conditions.

The complete story of Wireless in War.—Written exclusively for the Wireless Age by Lieut. Col. L. R. Krumm, officer in charge of Radio Division, Signal Corps, of the A. E. F. and Capt. Willis H. Taylor, Jr., Co-ordination Officer, Radio Section.

An unparalleled story of Wireless achievement.

Roger's Underground Aerials

THE Roger's wireless telegraph aerial for submarines is a closed circuit loop with a transmitting or receiving apparatus coupled at the middle as shown in the diagram figure 1. The antenna wires 11 are thoroughly insulated from the structure of the vessel except at the points 12 and 13 where a connection is made to the hull. An inductance connected in the middle of the antenna transfers the incoming signal to the detector circuit and the variable condenser 23 is employed as a tuning element. The same antenna is used for transmitting purposes, the primary of the oscillation transformer of the transmitting set being coupled inductively to the coil 16.



Method of installing the Roger's system aboard a submarine

Several forms of the Roger's underground aerial have been described in a recent U. S. patent. Figure 2 shows where the underground conductor extends horizontally or substantially parallel to the earth's surface. This aerial is enclosed with a metallic covering, casing or screen. 21 which may be a tube of lead pipe, iron or any other suitable material. The antenna is insulated from the metallic covering by means of the insulation 12; that is, although the antenna is buried in the earth it is completely insulated therefrom and from the metallic covering or casing.

The diagram of figure 2 shows a receiving apparatus inductively coupled to one end of the aerial, the other end (of the aerial) being ground to earth through the plate 25. A conventional type of transmitting apparatus, indicated to the right of the drawing, may also be coupled to the coil 24 for transmitting purposes.

In the modification shown in figure 3, the ground connection is replaced by a second antenna 20′ which extends in the opposite direction to the antenna 20. The signal instruments are located between the antenna and are coupled thereto by the usual inductive coupling. The signaling instruments are encased in a metallic chamber 26.

Figure 4 shows structure similar to figure 3 with the exception that the aerials lie on the surface of the ground. In figure 5, the antenna is elevated slightly above the surface of the earth being supported on struts or pins 28. The metallic covering in this case is not in direct contact with the earth. The covering may or may not be insulated from the earth.

Figure 6 shows two antennae of the Roger's type submerged beneath the water and figure 7 shows the employment of ground connection 30 at the outer end of the antennae.

The inventor remarks that careful tests and experiments have shown that by the employment of sectional metallic casing in intimate contact with the earth, but insulated from the radio conductor or antenna—the sections of the casing being insulated from each other and connected by couplings of insulating material—very much longer antennae may be employed than is possible with the continuous metallic casing. He also states that this construction reduces the interference of static.

Careful scrutiny of these diagrams leads us to believe that these underground aerials function like the closed circuit loops in the Weagant system, experiments on which were begun several years ago.

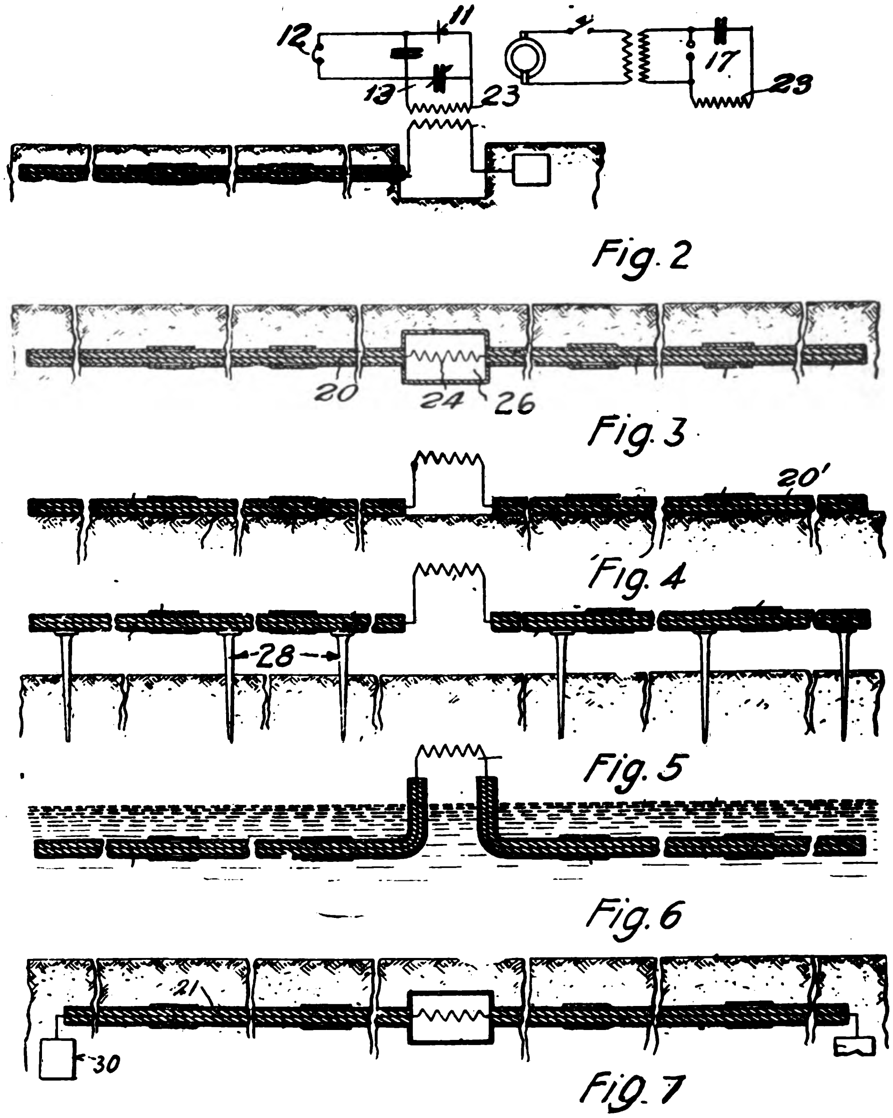


Diagram showing various arrangements of the aerials

Panel Transmitter

SEVERAL well designed transmitters have been described in this magazine but I have failed to see any that compared, in compactness, short leads and simplicity, with the transmitter shown in the accompanying drawings. It is designed for those who desire a compact and efficient transmitter instead of a cumbersome and complicated one.

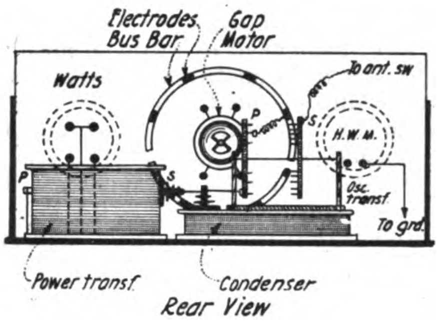


Figure 1.—Showing rear view of the panel transmitter

The panel is a marble slab 30" x 18" x 1½". Bakelite or some such material, however, is better since it is hard to obtain marble free from metal veins which would cause serious losses. It is supported by a baseboard 30" x 20" x 1" and is supported by brackets at each end. On the face of the panel is mounted a hot wire ammeter on the left, a Vernier type rotary gap in the center and a wattmeter on the right as shown.

The rotary gap has 12 stationary electrodes (only 8 are shown) in a 12" circle. A light rotating arm 10" long is mounted on the motor shaft and insulated therefrom. The 1/20 H.P., 6000 R.P.M. series wound motor is securely mounted on the rear of the panel, the shaft protruding through a ½" hole. Any fan motor will answer the purpose. A small rheostat mounted on the operating table, is hooked in series to vary its speed. The gap is quick to start and stop and produces a high musical note. It runs with less vibration than if a heavy disc was being propelled. It may be started and stopped by connecting to the antenna switch as shown in figure 4.

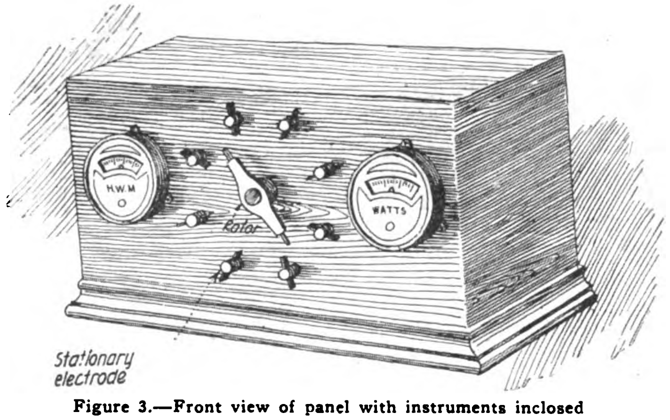


Figure 3.—Front view of panel with instruments inclosed

The stationary electrodes are connected in the rear by heavy bus-bar cut in two semi-circles, 6 electrodes on each half as shown. A bar ½" x ⅛" is used for electrodes.

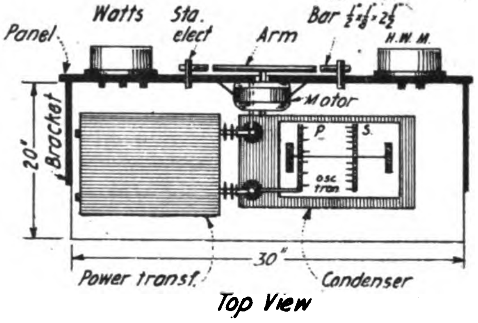


Figure 2.—Top view showing the position of the various instruments

The transformer is a 1 kw. open core with a variable reactance coil mounted in a case, allowing close variation of power. However, any well designed transformer will do.

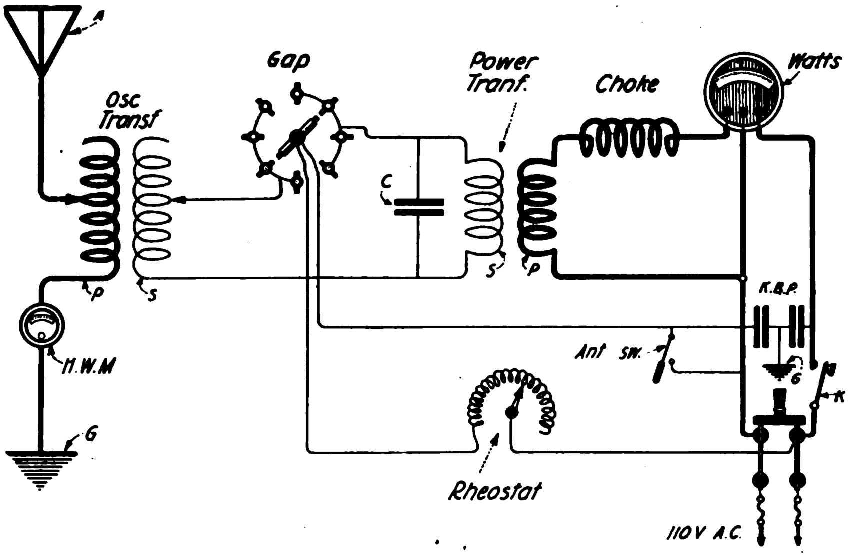


Figure 4.—Diagram of circuit used

The condenser is a glass plate, oil immersed type. Four banks of four plates each are connected in series parallel to reduce the strain on the plates. Its capacity should be about 0.008 mfd. for 200 meter wave. It is mounted so that the terminals will meet the transformer terminals which may be changed to make a short lead.

The oscillation transformer is placed on the condenser case as shown. Its base and uprights are hard wood with bakelite supports for the copper ribbon. The primary which may be stationary, has 5 turns of heavy ribbon. The secondary which slides on an insulating bar has 9 turns. In both cases the turns are spaced ¾" apart. The pancake type has proven more efficient than the "bird-cage" type. The connector used to vary the inductance is soldered to heavy flexible ribbon or wire. It is provided with a set screw so it may be secured well after tuning. One is sufficient for each inductance. Fixed values are not advised because changes in various things will require constant changes of inductance.

All low tension wiring is lead covered and the lead grounded. It should be run at right angles to high tension leads and as far away as possible.

Condensers are shown as protective devices, but the writer would advise a high resistance carbon rod placed across the line and grounded in the middle as condensers break down easily.

A switch may be used to cut the H.W.M. out of the circuit, but switches in the high tension circuits are sure to cause trouble and losses of energy.

If a little care is taken in placing the various instruments very short leads will result. A short ground lead and longer antenna lead is preferable than the reverse. Use of a magnetically controlled antenna switch and a relay key, allows remote control.

Herbert M. Walleze—*U. S. N.*

The Marconi V. T.—A Three-Electrode Oscillation Detector of Approved Operating Characteristics

AMATEUR experimenters who have been accustomed to use the audion detector will greet with pleasure the announcement that the Marconi Company is now able to supply three electrode tubes for experimental purposes in any quantities. Several types of vacuum tube detectors were developed for specialized services during the war, but realizing that a good majority of the amateurs are not in position to purchase a family of vacuum valves, the Marconi Company has provided an all-around detector of uniform operating characteristics which may be said to represent an average of the good points of all vacuum tubes.

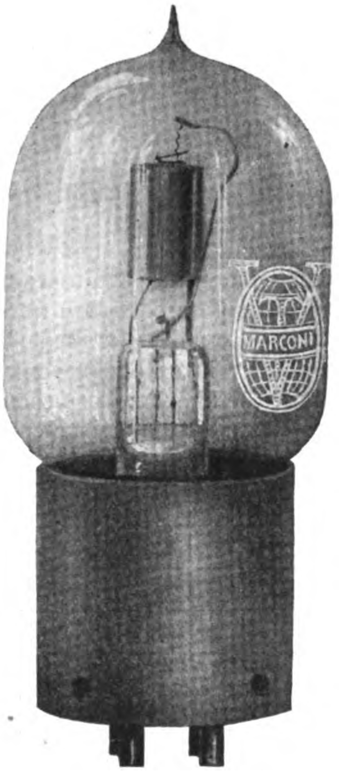


Figure 1.—The Marconi V.T. Oscillation detector

A point that will make special appeal to the experimenter is that the Marconi V. T.'s are standardized. This insures to all purchasers a uniform degree of sensitiveness and does away with one of the chief objections put forth by former buyers of vacuum tubes.

The Marconi V. T. is built to take the standard 4-contact base which makes all connections to the grid, filament and plate when the bulb is inserted. The tube has the usual grid, plate and filament. The filament operates off a four-volt storage battery without a rheostat. If a 6 volt storage battery is employed, a 10 ohm variable rheostat should be connected in the filament circuit. The filament current is approximately .7 ampere. The plate voltage for reception lies between 20 and 60 volts. In the amplification circuit shown in figure 3, the plate E.M.F. should be 80 volts.

The D. C. characteristics of the tube for various plate potentials up to 375 volts are shown in figure 4 and indicate uniformity. Figure 5 shows the curve of voltage amplification which compares favorably with other types of detector bulbs.

The preferred detection circuit in figure 2 shows the usual inductively coupled receiving tuner, the secondary coil of which is shunted by a variable condenser of say .0005 mfd. maximum capacity, although for the shorter range of wave lengths, this condenser may be dispensed with. The grid condenser may be fixed or variable. Its capacity should be approximately .0001 mfd. A grid leak of 2 million ohms is connected between the grid and filament in order to provide maximum ratification. The leak prevents the piling up of high negative potentials on the grid which otherwise would render the tube inoperative.

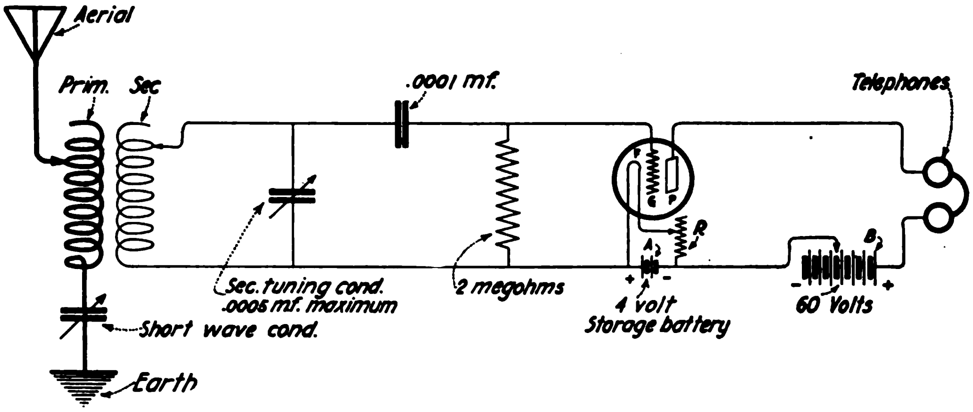


Figure 2.—The best detection circuit for the Marconi V.T.

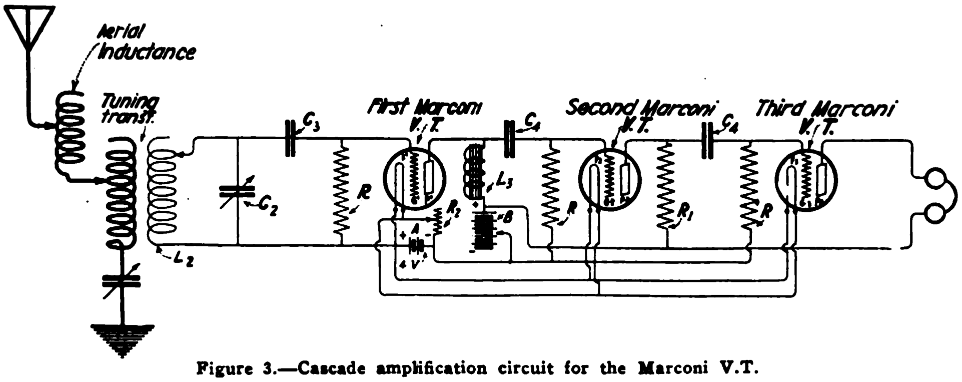


Figure 3.—Cascade amplification circuit for the Marconi V.T.

Although these leaks can be made by drawing lead pencil lines between two binding posts on cardboard, the Marconi Company has provided standardized leaks of 2 million ohms mounted on a base ready for use. This saves the user a good deal of experimenting, for unless he possesses a bridge for making resistance measurements he would have some difficulty in securing the required resistance.

For amateur experimenters who desire to work their 200 meter sets over great distances, the circuit for the cascade amplifier in figure 3 has been provided. It is believed that once the experimenter has an opportunity to observe the amplification which this circuit makes possible, he will employ none other. It is to be noted that the plate circuit of the first tube is coupled to the grid circuit of the second tube throught the choke L3; and that the plate circuit of the second tube is coupled to the grid circuit of the third tube through a resistance R-1 of 2 million ohms. The leak resistances R have resistance of 2 million ohms each.

A particular feature of this circuit is the use of a single battery for the filaments and another battery for the plate circuits of all tubes. The current consumption of the three filaments in parallel is approximately 2.2 amperes. The plate battery—commonly known as the "B" battery—should, in this circuit, have a potential of 80 volts for maximum amplification. The choke L-3 has an inductance of approxi-

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mately 20 henries. It can be made by winding 10,000 turns of No. 36 enamel wire on a core of silicon steel or iron wire ⅝" in diameter and 3" long. Condensers C-4 should have a capacity of .005 mfd. each.

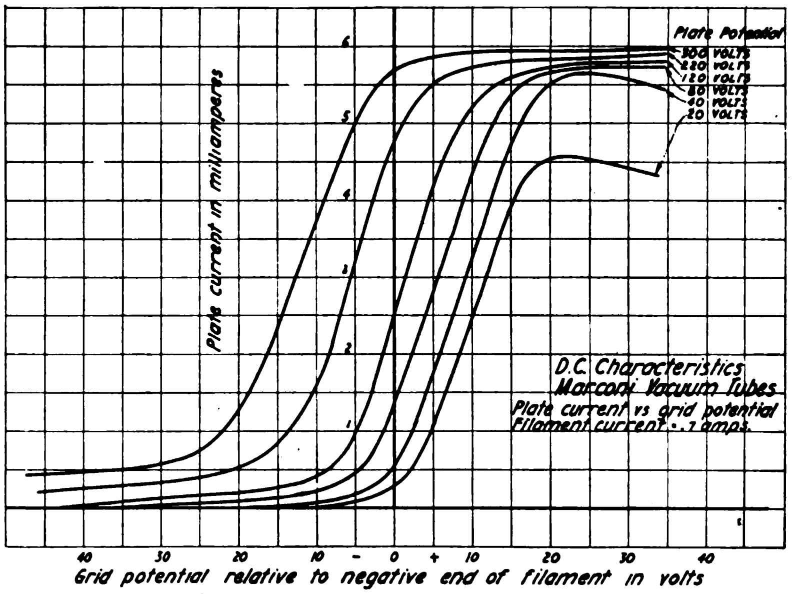

Figure 4.—The D. C. characteristics of the tube for various plate potentials indicate uniformity

There are certain precautions which the operator should take in the operation of this tube. It should be noted that its operating life is approximately 1500 hours and this means that if the amateur uses the tube four hours per day, its life will extend over a period of one year. By careful use of this tube, still longer life may be expected.

If the potential of the filament battery exceeds four volts, care should be taken not to exceed the stated filament current of .7 ampere.

The required filament temperature can be obtained without an ammeter by putting 60 volts on the plate circuit and then carefully adjusting the rheostat until loud signals are obtained for distant stations. Other values of plate voltage should then be tried and different filament temperatures keeping the filament current well within the limits.

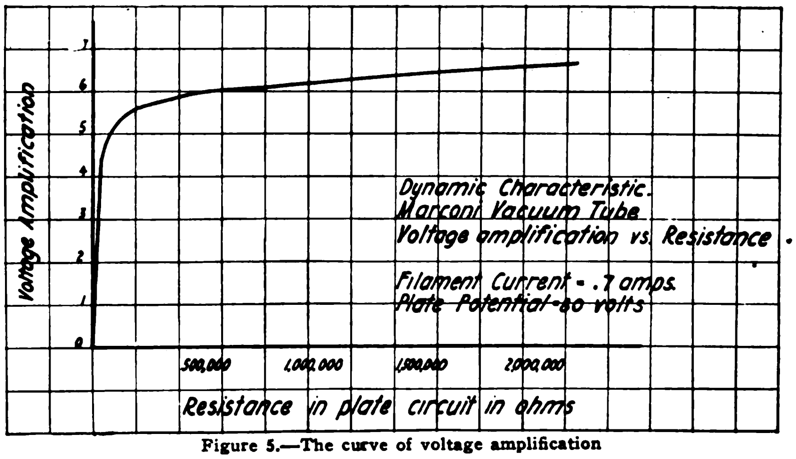

Figure 5.—The curve of voltage amplification

The filament should not be burned at higher temperatures than are necessary for strong signals as lower temperatures will tend to prolong its life.

If a battery in excess of four volts is used for the filament, care should be taken to cut in all the resistance at the rheostat immediately after the valve is put out of service, for otherwise the storage battery may recuperate sufficiently, while standing idle, to burn out the filament the next time the filament circuit is closed.

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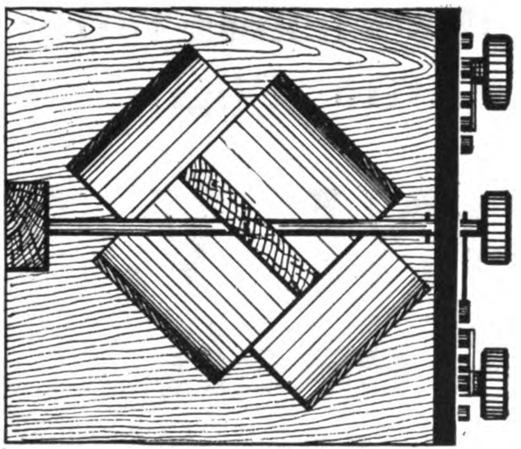
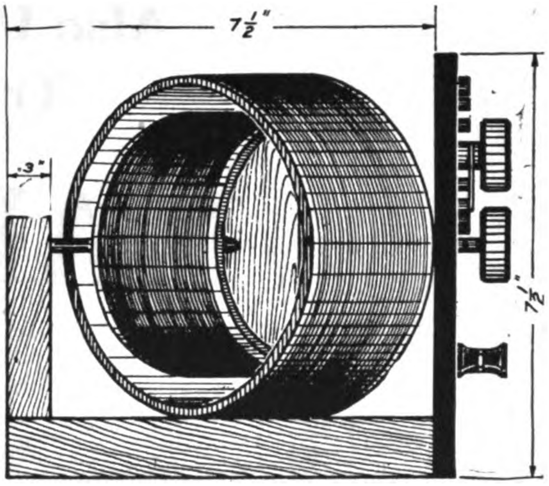
A Receiving Transformer for Arlington Time Signals

THE receiving transformer shown in the accompanying drawings is suitable for the reception of wave lengths up to 3,000 meters when used with the average amateur antenna. The unusual feature of this transformer is the method of mounting the primary and secondary coils. Each coil is mounted at a 45 degree angle with the shaft. This permits the coupling to be varied through a 180 degree scale, and allows room for the shaft to pass through without interfering with the windings.



Top plan view of the receiving transformer showing primary and secondary coils mounted at a 45 degree angle with relation to shaft



Side elevation and dimensions of construction

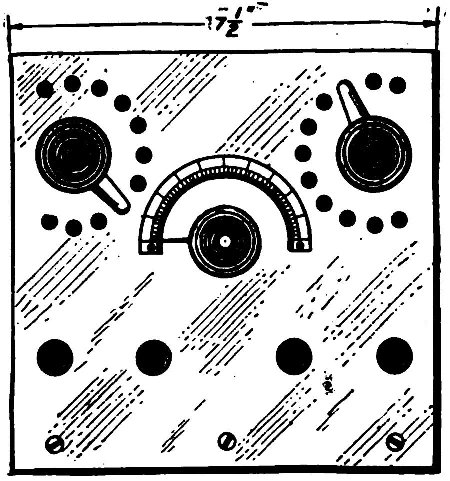
The primary inductances consists of 200 turns of No. 28 S.S.C. wire wound on a shellaced paper tube 6" outside diameter, 3¼" long, 3/16" thick. Eleven equally spaced taps are brought out and connected to one of the 11-point switches on the hard rubber panel. The tube is clamped to the base with a metal strip held down at each end with a wood screw. The inductance of this coil is approximately 6,000,000 centimeters.

The secondary inductance consists of 240 turns of No. 30 S.S.C. wire wound on a shellaced paper tube 4½" diameter, 3" long and 3/16" thick. Eleven equally spaced taps are brought from this coil to another 11-point switch, with extra flexible green silk covered telephone cord. These leads should pass through 11 holes drilled through the wood block which supports the tube, near the shaft, so as to reduce the strain on the connections. All connections must be soldered. The tube is mounted on the block before winding and held with 6 pins, three at each end. The inductance of this coil is approximately 6,000,000 centimeters, and when shunted by a capacity of .0005 mfd. will respond to a wave of 3,250 meters.

The shaft is of hard wood ¼" in diameter by 8½" long. It passes through the secondary coil support at a 45 degree angle and is held by a wooden pin glued in place. The knob is turned from ½" hard rubber and pinned to the shaft.

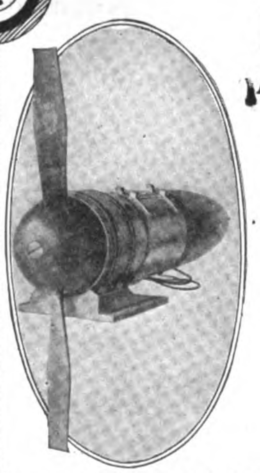
The base is of hard wood 1" thick. The panel is fastened to the base with 3 wood screws as shown. Four hard rubber binding posts are mounted on the panel, two for the secondary and two for the primary.

This scheme of coupling may be used with any size of tuner, and can easily be mounted on a panel or cabinet set with other apparatus. A variometer connected in series with the primary will be useful when close tuning is desirable. The coupler can be used with an ordinary crystal detector, but is intended primarily for audion work.



Panel board with switches and binding posts mounted

Clyde J. Fitch—*Massachusetts.*



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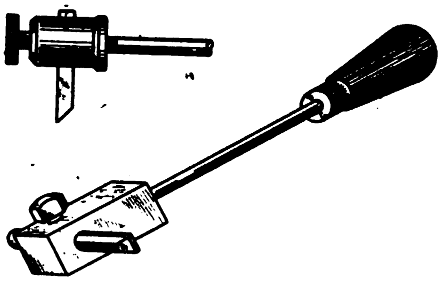
C. H. BIRON—*Massachusetts.*



Improved soldering tool for delicate work

Contest Winners for August

The June WIRELESS AGE subject for discussion was: "What are the relative merits of the regenerative vacuum tube receiver and the cascade vacuum tube amplifier for radio reception at amateur wave length?"

First Prize—The Regenerative Receiver and the Cascade Amplifier for Amateurs

IN pre-war amateur stations, the cascade amplifier was usually regarded as an expensive luxury, because of the necessity of a separate battery for each bulb, and the multiplicity of other equipment required. In addition, it was difficult to adjust readily, and because of these defects it found only a limited application, being more of a novelty than a utility.

At the hands of modern research engineers, however, an improved type of vacuum tube was evolved, which does away with the critical adjustment required by the old type of tube and makes the cascade amplifier a practical device. Tubes similar to this are now being placed on the market for the amateur experimenter, and through their use, we may expect the cascade amplifier to become common in all of the more advanced amateur stations, taking the position formerly held by the regenerative receiver.

The most common regenerative circuits in use at the present time are of the following types: The variometer type, as used in a popular amateur receiver; the tickler coil regenerative, largely used by the U. S. Navy; the condenser regenerative; and the single coil, direct-connected type, used in the Simon airplane receiver. There is still another type which was described in the june WIRELESS AGE by Mr. M. W. Sterns. These are all fairly simple, requiring a minimum of apparatus, a single vacuum tube, and only one set of batteries. Since the upkeep cost of the batteries required for a cascade receiver is considerable, there is no doubt but that the regenerative set will always remain popular among amateurs of limited means. Another point in its favor is the simplicity of adjustment which is so essential when interference is bad, although, as I have already mentioned, the cascade amplifier in its perfected form is equally simple. The main points in favor of the regenerative receiver for amateur purposes, are: Low initial cost; greater simplicity of apparatus; and lower upkeep cost of batteries and tube renewals.

The cascade amplifier, on the other hand, is absolutely necessary for certain types of receiving work, as with the directional loop antennae, the use of which would be a long step forward in solving the interference problem. Also, the use of recently perfected static eliminators will make it possible to use a greater degree of amplification which should permit some remarkable receiving ranges.

The question of supplying battery current for a multi-stage amplifier is best met by using a medium-sized storage battery of perhaps 60 ampere

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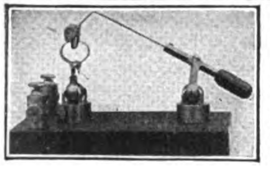

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hours, and having a rectifier or charging machine at the station. With an efficient rectifier such as the Tungar or a small motor generator, such a battery can be charged once a week at a cost of about fifteen cents, whereas battery stations usually ask a dollar or more. The initial investment required will soon be repaid by the money thus saved.

The successive tubes in the cascade amplifier are coupled together by three different methods, by resistances, by impedances, or by transformers, any of which can be constructed by the amateur, or purchased at a moderate cost, so that the chief outlay will be for the tubes and battery equipment. Summing up these considerations, we find a large initial cost, larger upkeep cost, wider application for new receiving devices, and increased receiving range, which would seem to indicate that the cascade amplifier will be a necessity in the truly modern amateur station.

Arno A. Kluge—*California.*

Second Prize—Regenerative vs. Cascade Amplifier

The regenerative audion circuit is popular for several reasons. Its low cost is the special inducement which attracts the radio amateur. The operating results are very satisfactory, amplifications as high as one hundred times being recorded. Only one tube which acts as detector and amplifier is needed, and there is only one high voltage and one low voltage battery to regulate. The number of adjustments in the secondary circuit are few, only three or four variable condensers being necessary. The regenerative circuit is almost equally effective in receiving undamped waves, thus adding to the utility of the set.

The cascade amplifier is a very fine instrument for boosting weak signals to audible ones. The principal objection to its use is the prohibitive first cost—an audion detector and several amplifier units being required. The cascade amplifier using one plate and one filament battery is just beginning to be recognized by the experimenter, and if he possesses the funds to buy a set of this kind, he will put it all over the fellow with a single bulb set.

In some cases each amplifying unit has a separate high and low voltage battery unit, and these are so closely related that an expert is needed to operate them. The amplifier is a very effective instrument; but for the average amateur it is a little beyond his reach. The regenerative circuit gives remarkable results with careful handling, and being simpler than the cascade amplifier it continues to grow in favor with the progressive radio amateur who is impressed with practical results.

R. C. Hitchcock—*Connecticut.*

Third Prize—This Experimenter Prefers the Regenerative Receiver

It is claimed by one of the editors of a contemporary radio publication that the vacuum tube cascade amplifier is far superior to the regenerative valve for amateur work. The editor bases his claims on the matter of reliability, claiming that the regenerative set will work one minute and won't work the next; that, in some cases, it works very satisfactorily when the amateur has no traffic to handle, but when it is most needed, the bulb cannot be made to oscillate for the love of money.

It seems to me that the set to which the gentleman referred is quite typical of some of the amateur home-made regenerative sets, but I can assure him that if he has ever operated a regenerative set using the proper circuit he has a 100 per cent. fool-proof set.

If the amateur will choose a circuit which secures good amplification a good bit below the oscillating point of the bulb and if he fits his aerial change-over switch with contacts to break the "B" battery circuit while transmitting, and not the "A" circuit, he will always "come-back" from transmitting and find the bulb adjusted to almost perfect amplification. If the *filament circuit* is broken when sending—not the high voltage circuit—the "A" battery invariably picks up a bit and he finds the set completely out of adjustment when he switches over to receive. The reason for breaking the B circuit and not the A battery is that the B battery's "picking up" does not affect the operation of the bulb as much as the A battery does.

Another point in favor of the regenerative set is the matter of low cost, as compared to that of a 3-step amplifier. I will admit that the amplifier is more suitable for reception over a longer range of wave lengths than is the regenerative set, without changing as many adjustments, but as the amateur wave is pretty closely defined between 200 and 425 meters, it is a comparatively simple matter to adjust the plate inductance, be it a variometer or a tapped coil.

I doubt whether a 3-step amplifier and a detecting valve are as "fool-proof" in operation as some may believe unless a modern circuit using one filament and one plate battery is employed.

Don't you think that it is a little early to predict the use of undamped oscillating sending sets for amateurs? It certainly cannot be expected until some kind manufacturer comes out with a nice little high voltage DC motor generator set at a price somewhat in reason.

I have been wondering quite a bit lately whether we may not predict transoceanic amateur communication before so very long. There certainly must be at least one amateur in England who could help us out at that end of the line—as soon as the Britishers come out of their "ban-ishment"—and I know there are several amateurs in New York City who can most assuredly offer the best that can be had in amateur apparatus. Figure it up, and you will see that the air-line distance from New York to some city in England is not so terribly much greater than is the distance some of the U. S. "hams" covered in the long past season of 1917. In addition look at the great expanse of water we have to work over—practically all the way across. I've been thinking long and hard of this thing and want to see some of the "boys" up in New York City try it out. I feel sure before many seasons pass that it will be done. If you think it worth while trying, and to get the matter stirred up, I can give the names of two amateurs in England whom I know would be eager and willing to co-operate with our American friends in making tests.

John M. Clayton—"5 *BV.*"

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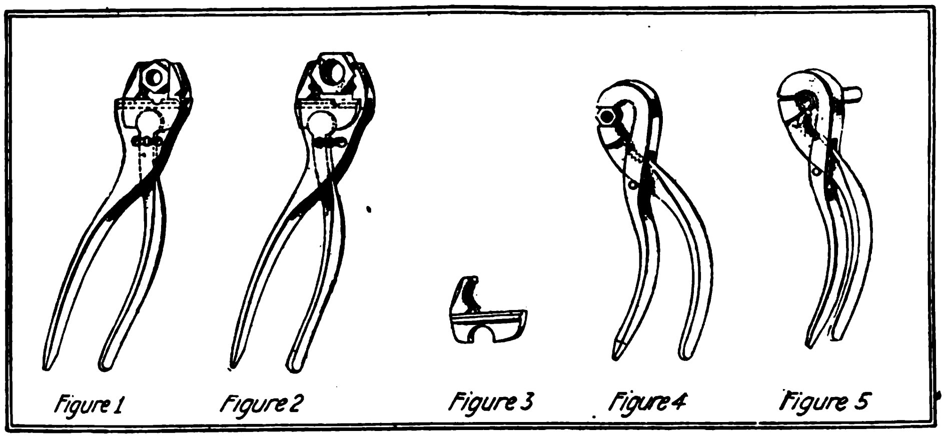
A WESTERN inventor has brought out two types of plier wrenches that will fill a long-felt want in any mechanic's tool-kit. These wrenches are quick-acting, self-adjusting, always taking a firm grip on any object that may be clamped in the jaws.



Improved mechanic's pliers suitable for extensive use

Their construction is simplicity itself.

The main feature claimed for the wrenches is that the jaws are always parallel when clamping objects of various sizes whether the jaws are closed or wide open. When clamping nuts, pipes or objects of various sizes, the grip of the handle is always the same.

In figure 1, the jaws are clamping a medium size nut while in figure 2 they are holding a large size nut and the jaws are nearly entirely open. It will be observed that the handles are in about the same position irrespective of the jaw opening.

Drawing No. 3 shows a pipe jaw that is interchangeable with the regular jaw used for nuts. This attachment proves very valuable for loosening nuts that have had the corners rounded off. The pliers may also be used as a pipe wrench.

In sketch No. 4 a special form of pliers are shown gripping a medium size nut. It is to be noted that the jaws are parallel, and that the handles are far enough apart to give good leverage. This plier wrench has no adjustments. It is semi-automatic and self-adjusting to any size, such as nuts or pipes that may be clamped in the jaw.

In drawing No. 5 the jaws are nearly closed and are gripping a small size pipe. Note that the jaws are parallel the same as they are in figure 4 gripping a medium size nut. An eight-inch pair of pliers will take a three-quarter inch pipe. Moreover, it has a parallel jaw opening that will take in any flat object such as a nut. As these plier wrenches have hook jaws and end openings they will appeal particularly to steam fitters, electricians, automobile owners and mechanics in general.

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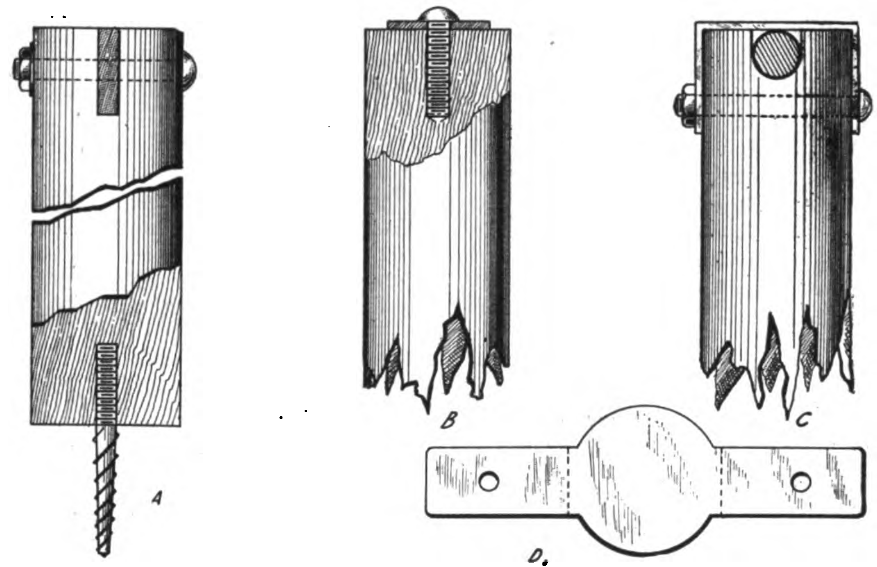
The size of the rod used will vary according to the size of conductor to be run flat upon the supports, it can be secured by a machine screw passing through the strip into a threaded hole in the top end of the rod, as at B.

If the conductor be of circular cross-section as in the case of wire or tubing, then the method shown at C can be used. This consists of forming a groove in the top end of the rod of such a depth that the conductor comes flush with the top of the rod when it lays in the groove. It is held in position by a cap made of a piece of sheet brass with two ears (see figure D), that extend down on either side of the rod and is clamped by a 6-32 screw



Drawings showing various styles of improved lead supports and the method of construction

be carried, but ¾″ diameter by 4″ high will be found to possess the required mechanical strength and right proportion. There is nothing to be gained by using a much greater diameter rod than this and the expense mounts rapidly with increase in diameter; on the other hand, a smaller diameter is too weak mechanically, and gives the insulator an appearance of frailty. As depicted in the drawings, a wood screw of about No. 10 or No. 12 size and 1¾″ long has its head sawed off and the smooth portion threaded with a 10-24 thread. The length of this machine thread will be about ¾″. It is screwed into a hole drilled and tapped into the bottom of the pillar, leaving about 1″ of wood screw thread protruding. If the conductor is flat strip or ribbon, and it is desired to support it on the pillars in an edgewise position, a slot can be sawed in the top of the rod for a depth equal to the width of strip and the same held in place by a machine screw passing through the rod and strip as at A. Where the strip is to passing through the same. If desired, a plain tie wire may be used in the place of the metal cap. However, this is not so good because all the sharp projections of the tie wire would be present. This should be avoided on a conductor carrying currents of high voltage and high frequency. Another and probably the simplest method that can be utilized, is to merely bore a hole through the rod to slip the conductor through, and after all the pillars are fastened in place the conductor is threaded through the holes in same. There are still other means of fastening, but they require the chasing of threads on a lathe which is not always available. When the pillars are mounted on brick walls a hole should be drilled in the wall with a star-drill and plugged with a soft wood plug to accommodate the wood-screw. If a lathe is handy, the pillars may be turned to a taper and a series of grooves may be cut on the surface of the rod. The only real requirement is that the ends be cut off square.

J. A. Weaver—*Maryland.*

The Monthly Service Bulletin of the

NATIONAL WIRELESS ASSOCIATION

Founded to promote the best interests of radio communication among wireless amateurs in America

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Radio Telegraphy vs. Telephony for Amateurs

MANY are looking forward to the time when amateur communications will be carried on by the wireless telephone instead of by the familiar wireless telegraphy. The writer is of the opinion that such a time will never be for the reasons that are given in this article.

Prior to the war the radio amateur station had reached a high state of efficiency. The entire country was threaded with the so-called "trunk lines" and the public was being well served in many localities. The short wave regenerative set was being perfected, and efficient 200 meter transmitters were a known quantity. Had not the war interfered a very high state of perfection would have been reached.

The war called many of us and gave us a taste of Government and commercial wireless operating. Many improvements were made. Vacuum valve circuits were brought down to perfection, the barrage receiver was invented, ground wires and loops came into use and static was substantially eliminated. The vacuum valve transmitter for wireless telephony has been improved to such an extent as to allow speech transmission for hundreds of miles.

The war is now over and the amateur is returning to his old line of work. Trunk lines will be carried to a point of perfection, the non-synchronous gap type of transmitter will be pushed to the limit, many amateurs will do serious work with the vacuum tube wireless telephone and some may cover distances of from 100 to 300 miles, but the end of the wireless amateur insofar as the radiophones is concerned is in sight. Large concerns have invested thousands of dollars in the wireless telephone and are going to make it take the place of the ordinary line phone. This will be possible through the use of recently perfected interference eliminators. The long lines between central stations will go down first. Their place will be taken by the high power radio telephone transmitter. Although a number of years may elapse the local lines will be the next and last to go down. Their place will be taken by short range radio telephone sets operating as before in conjunction with a central exchange.

It suffices to say that when wireless telephones become universal there will be no novelty connected with them and the amateur will look for fresher fields of experimenting which will not be the wireless telephone.

J. STANLEY BROWN.

Good Sense Dictates the Design and Mounting of a Radio Set

THE term "radio amateur" is synonymous with "experimenter." His motto is efficiency spelled with a big "E" and he forever strives to increase the range of his set with unceasing vigilance and tireless energy. In order to secure this increased efficiency, it frequently becomes necessary to rearrange and change the connections of the apparatus. Then too, in the event of the adoption of some new and up-to-date piece of apparatus corrections are also necessary.

When the instruments are mounted on a panel, they usually present a more "commercial" appearance, much desired by some amateurs. However, the progressive element are more desirous of results and are willing to sacrifice mere appearance for range. It is upon this element that progress in the art is dependent. Since it is the customary condition of the average amateur to be financially embarrassed, which means that his funds are inadequate to secure instruments which he

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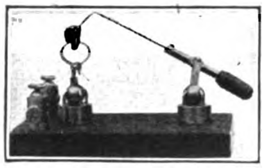

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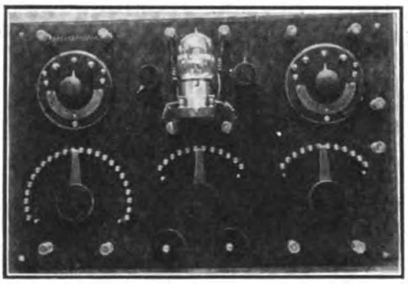

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242 pages, 6x9, 179 illustrations, $2.00, net postpaid.

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knows will increase the efficiency of his transmitter, he will readily realize the economy of a practical and efficiently grouped arrangement of instruments. In case that he already has the instruments mounted neatly on a panel and sees that the arrangement is inefficient or an individual piece of apparatus has become defective, the cost of making the changes are increased and it is very likely that the appearance of the panel will suffer thereby.

So that if the amateur will content himself with a neat arrangement of his instruments with a view of securing maximum efficiency through shortening the connecting leads, etc., he will be amply rewarded by a corresponding increase in the effective range of his transmitter.

P. L. WELKE—*Maryland.*

Suggestion for Prize Contest OCTOBER Wireless Age

* * *

We will pay the usual prizes of $10, $5 and $3, in addition to our regular space rates, to the three contributors who send us the best manuscripts on the following subject:

What type of oscillation transformer is best suited mechanically and electrically for 200-meter transmission and what are the constructional details?

Hawkeye Radio Association

ALL radio men residing in Iowa should register their names and addresses together with all information concerning their experience, with Mr. J. W. Silcott of Brooklyn, Iowa. Reorganization of the Hawkeye Radio Association has been started by a few of the old members under a new plan with a larger scope of action. This plan is similar to that described in the February, 1919, issue of the WIRELESS AGE.

The Association would be glad to hear of the plans of other middle west organizations. It is believed that certain details of the work of a state organization could be carried out better if all state organizations could be "leagued" together. In order to do this, there should be a similarity of scopes and aims.

The H.R.A. would like to hear discussions of the above plan.

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Amateur Wireless Telephony

PRACTICALLY every live, up-to-date amateur has read and studied something of radio telephony. There have been innumerable articles and books on this subject describing the theory and practical uses of the wireless telephone. Some articles even tell how to make a small vacuum tube transmitter.

Amateurs will undoubtedly experiment a great deal along these lines and probably an efficient short distance set will eventually result. If correctly designed, a small transmitter using the ordinary audion bulb and having about 100 volts in the plate circuit is capable of transmitting the voice from three to four miles. By connecting another bulb in parallel and increasing the plate voltage, the range may be increased. A set of this kind may be easily constructed by the amateur, because many of them own audions. Although it is not meant to go into constructional details, it may be said here that it is fairly simple to construct a low amperage storage battery out of test tubes and lead strips, which, when charged by a home-made electrolytic rectifier is capable of delivering one hundred volts or more. It is, therefore, safe to say that many experimenters will construct sets of this kind for local work.

The range of communication, however, is limited. The only reason radio telephone transmitters of sufficient power to send 100 miles or over will not be used among amateurs, is their high cost. A set of this kind requires a high D.C. plate voltage, probably of at least 500 volts, and as alternating current is usually the only kind available some sort of rectifier must be used. Even then, a 500 volt A.C. source must be had. The only other way of getting high D.C. voltage is to use a motor generator.

The total cost and up-keep of such a set may be beyond the means of the average amateur. Of course, advanced experimenters may, and in all probability will, make and use sets of this kind but they are of small number.

In summary, it may be said that wireless telephony will, in the near future rival, if not take the place of wireless telegraphy in local work; that is, within a radius of about ten miles. For all other radio work, wireless telegraphy will hold its own. An efficient one kilowatt station will transmit reliably a distance of 300 miles and if a special short wave regenerative receiver is used at the receiving station, the range may be further increased. A radio telephone transmitter of this range would cost many times as much to construct and be much more expensive to operate.

Ralph Foss—*Illinois.*

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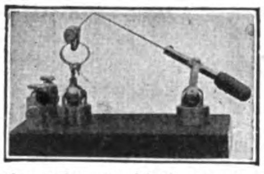

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Queries Answered

Answers will be given in this department to questions of subscribers, covering the full range of wireless subjects, but only those which relate to the technical phases of the art and which are of general interest to readers will be published here. The subscriber's name and address must be given in all letters and only one side of the paper written on; where diagrams are necessary they must be on a separate sheet and drawn with India ink. Not more than five questions of one reader can be answered in the same issue. To receive attention these rules must be rigidly observed.
Positively no Questions Answered by Mail.

R. B. C., Los Angeles, Cal.:

The "hard" Marconi V.T. will meet your requirements. The "soft" bulbs are particularly suitable for detection purposes.

A book will shortly be issued by the Wireless Press that will give full details concerning the construction of an amateur wireless telephone set capable of working fifty miles. Low power vacuum tube transmitters, say of 10 watts output, do not require an induction coil to modulate the antenna currents. It will be sufficient to connect the microphone in series with the earth lead, shunting the microphone with three or four turns of copper wire wound on a mandrel 4" in diameter.

It is recommended that you purchase a small 500 volt generator to energize the plate circuit of your transmitter. One hundred dry cells will not give a potential of 250 volts.

Regarding the diagram in the Wireless Age: the middle tap leading to the tube filament need not be variable, but the taps leading to the grid and plate circuits should be variable.

In the second edition of "Vacuum Tubes in Wireless Communication" you will find up-to-date diagrams of tube transmitters, the construction of which is for the most part self explanatory.

* * *

C. S., Bishop, Cal.:

You should have no difficulty in selecting from the advertising columns of this magazine a receiving set that will meet your requirements. Several amateur manufacturers can supply you with a long wave set.

* * *

F. G. S., Graniteville, Mass.:

We do not know of any manufacturer that will supply you with a vacuum tube wireless telephone set. So far this apparatus has only been manufactured for the government. Any vacuum tube receiving set will record wireless telephone signals.

* * *

J. R. P. Jr., Parkersburg, West Va.:

You can reduce the power input of your transformer to ½ kw. by connecting a reactance coil in series with the primary. Wind up a choke of 4 layers of No. 10 wire on a core 2" square and bring out several taps at regular intervals. The core should be 14" long.

* * *

A. S. K., Great Lakes, Ill.:

Regarding the variometer described in the May issue: It is intended that the field frames have 30 turns each, and the rotating balls 32 turns each.

* * *

H. S. W., Dover, Ohio:

You will undoubtedly find it a difficult matter to eliminate the inductive interference from the high tension power line you mention. Some amateurs have achieved success by running a small aerial parallel to the power line and coupling it inductively to tuner secondary in such a way that the currents induced in the receiving circuits will be opposed.

* * *

H. G. F., Bensenville, Ill.:

The vacuum tube detector is by far more sensitive than silicon or any other crystalline detector. All of the textbooks issued by the Wireless Press, pertaining to radio, contain diagrams applicable to your needs.

* * *

A. B. L., Chicago, Ill.:

The secondary of a spark coil or a high voltage transformer often is suitable as an intervalve coupling in a cascade amplifier.

The impedance of the intervalve coupling should at least be equal to the internal impedance of the tube. If the impedance of the tube is known, a number of secondary transformer pies of equal impedance can be selected. The impedance of any choke may be measured by connecting it in series with a 500 cycle source. A voltmeter should be connected across the coil, and a milliammeter in series. The reading of both should be noted and the resulting data inserted in the formula $Z = \frac{E}{I}$, where Z = the impedance in ohms.

Some telephone receivers have sufficient impedance to be used as intervalve couplings. The impedance of one standard headset at 500 cycles is 22,000 ohms. Two such telephones in series will be sufficient for the average valve.

Two megohm resistances are used as intervalve couplings with the Marconi V.T. A booklet accompanies each valve showing the best circuits for reception.

* * *

D. R. J., Boston, Mass.:

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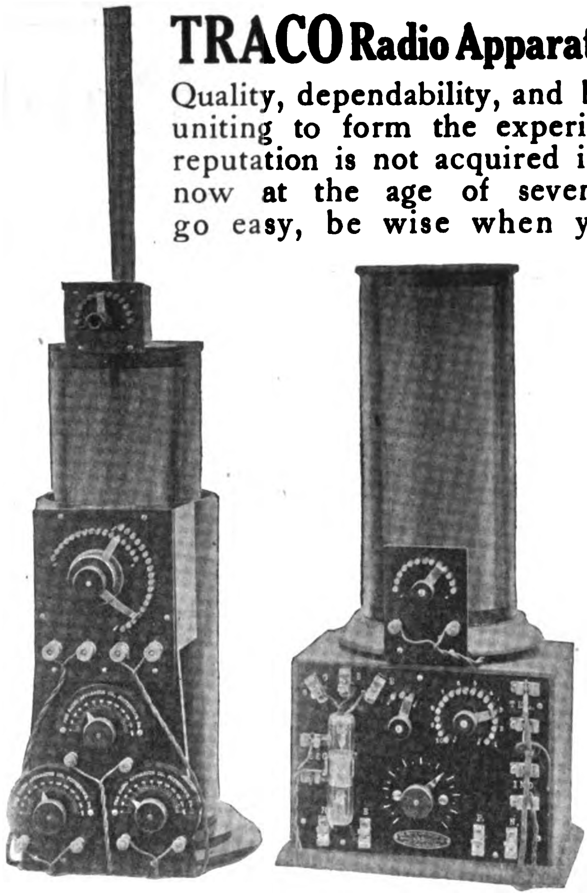

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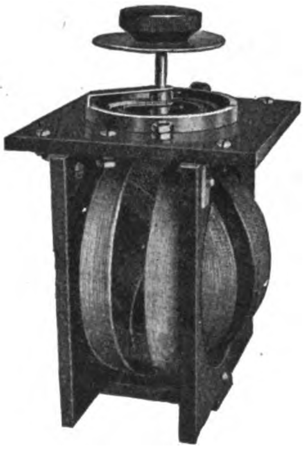

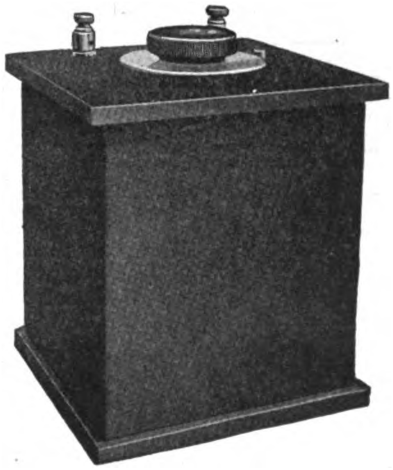

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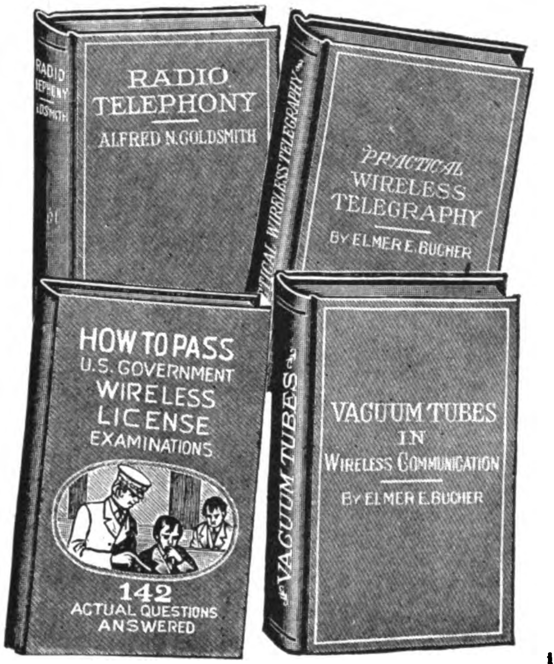
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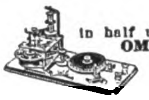

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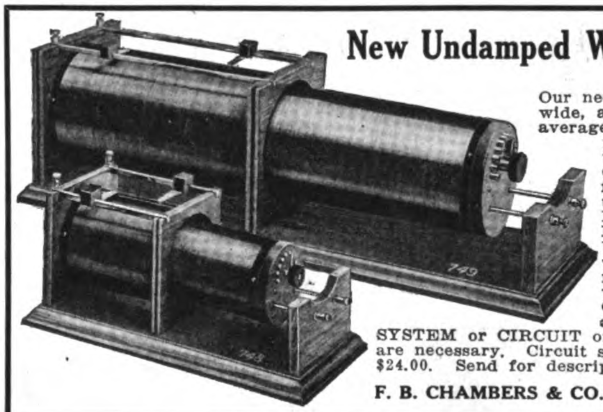

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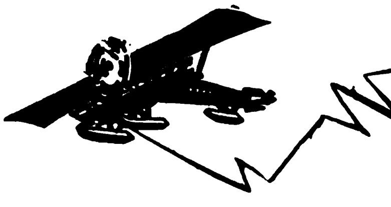

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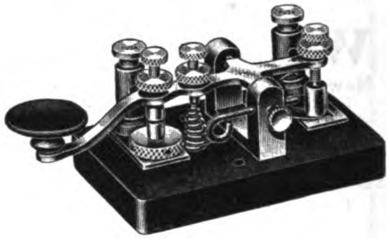

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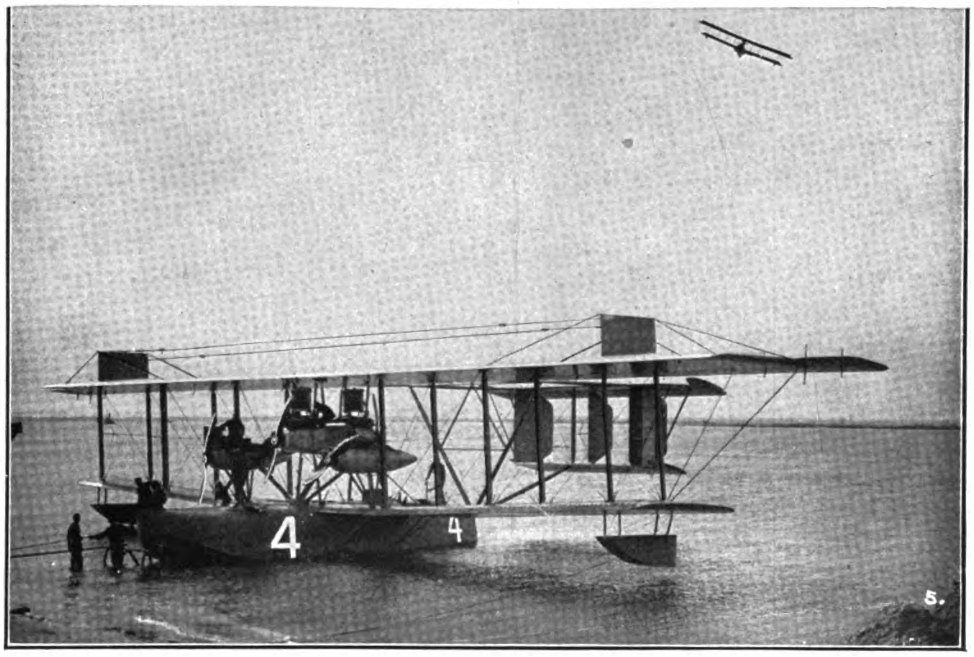

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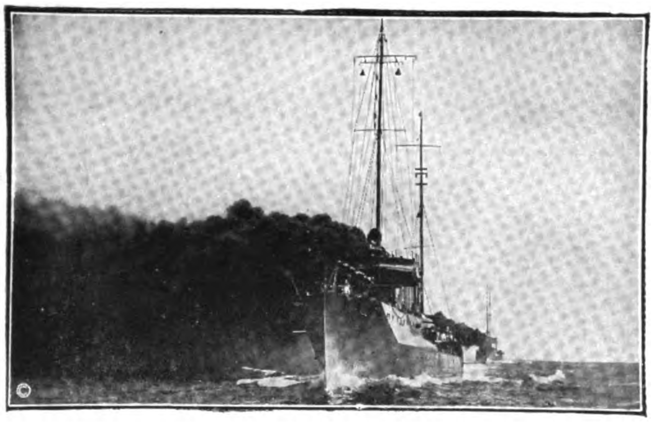

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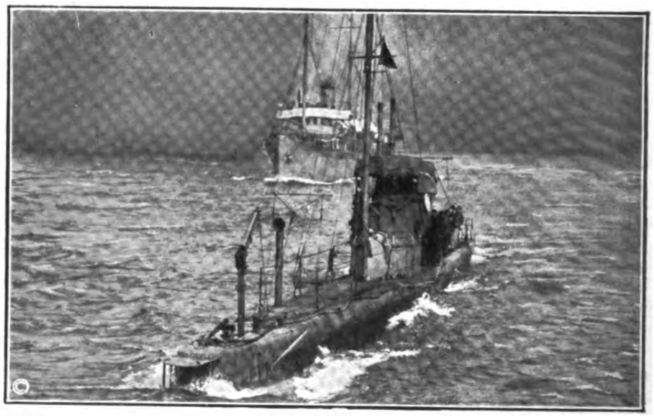

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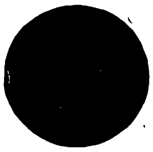

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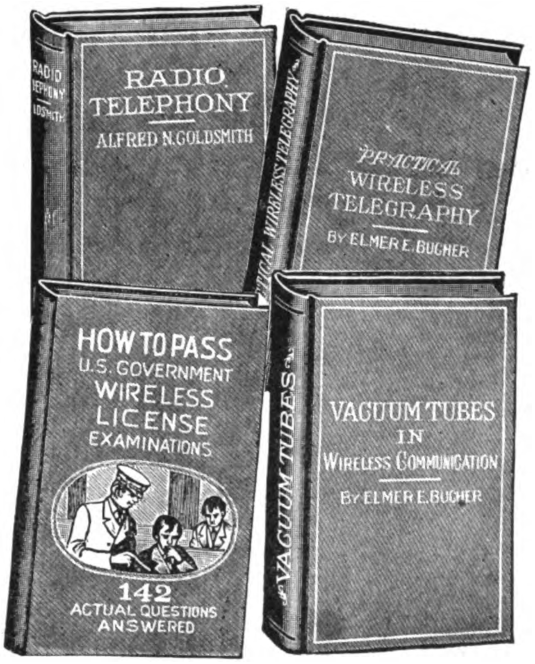
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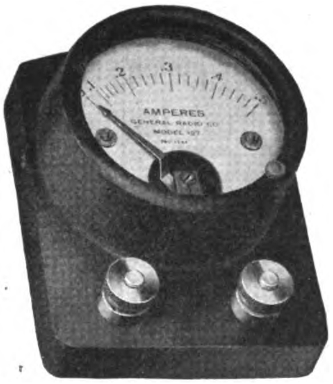

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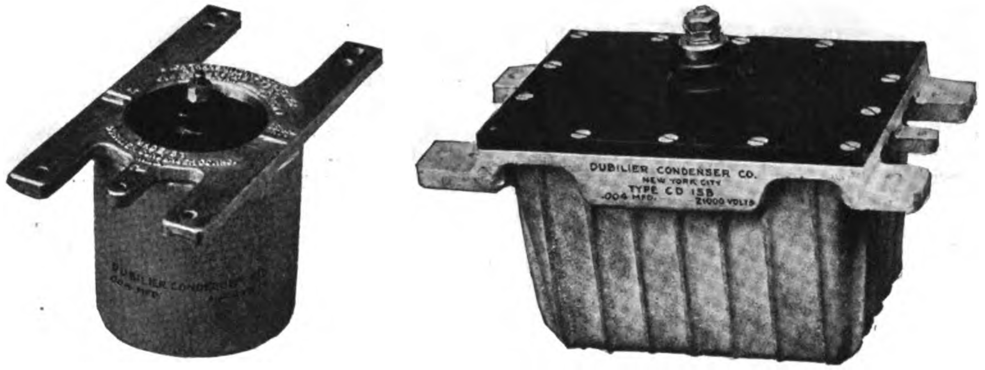

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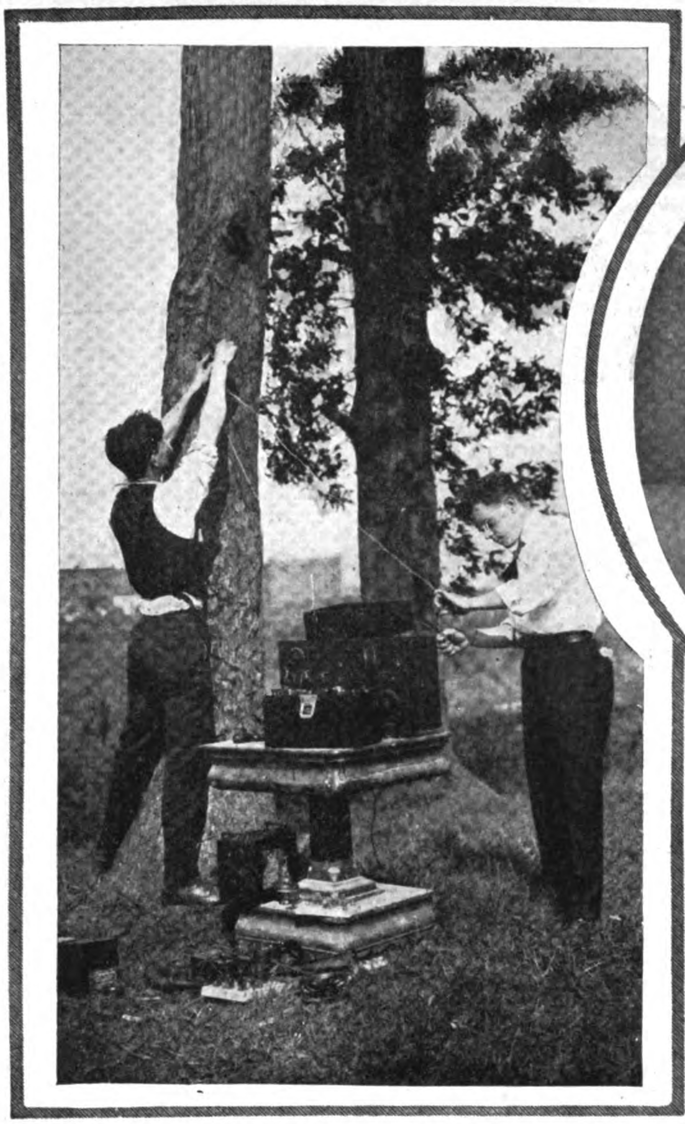

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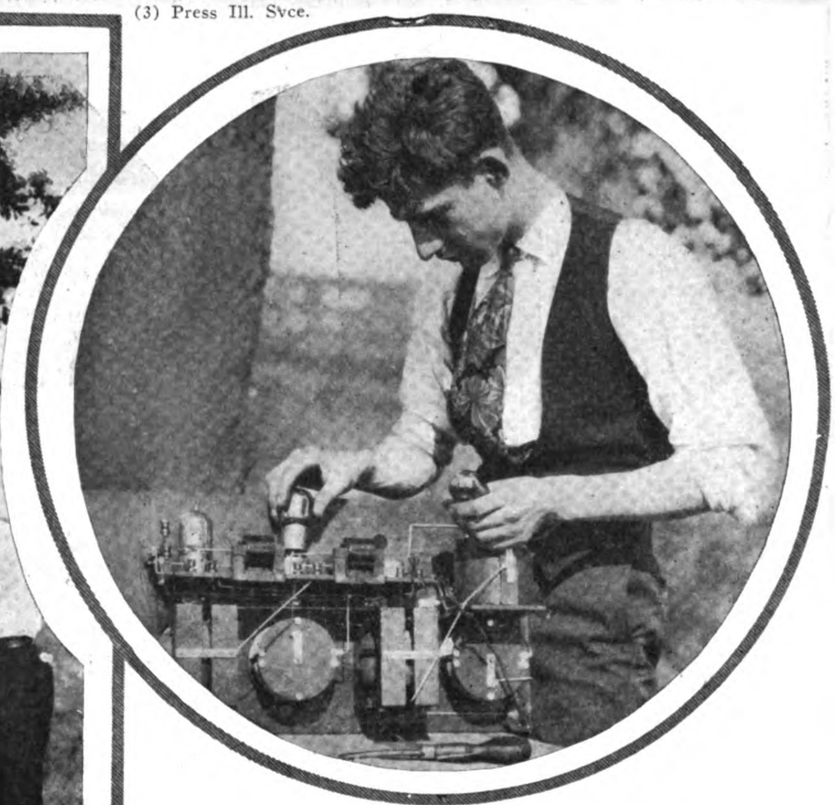
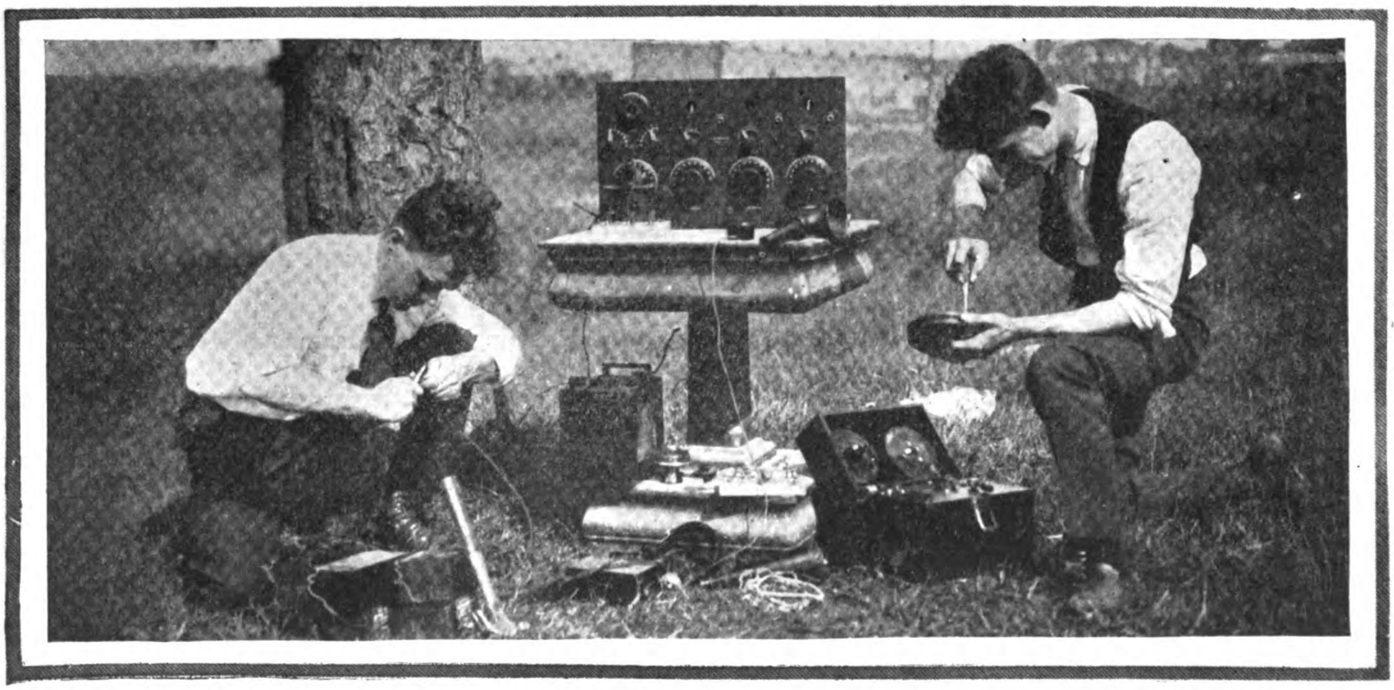


Wireless in the Wood

So considerable were the improvements made in the use of tree antenna for wireless communication during the war period that interest has been revived in amateur experiments along that line. . Long distance transmission and receiving, duplex operating and radio-telephony has been accomplished

The receiving apparatus shown above is of the modern type; the picture shows the rear view with the Marconi V. T. bulbs being placed in position

On the left is a view of the method of rigging the lead-in wire



Walter Wehmann on the left and James Candido on the right are two of the number of tree-antenna-enthusiasts

Vol. 6. No. 12. September, 1919

THE WIRELESS AGE

WORLD WIDE WIRELESS

New Method of Producing Electric Current for Use in Wireless

According to "Norges Handels og Sjofartstidende," Engineer Hermod Peterson has recently patented a device for the production of electrical current for radio-telegraphy. The electricity is received by an accumulator, which releases it at certain intervals. The system is sparkless, and the sounds are clearer than in the older inventions. The clearness of sound depends upon the regularity of the current, and with this system the current is released with a mathematical exactness. The device has further advantages in that it is cheaper, simpler, and more durable than those now in use.

If the claims made for this invention prove well founded it is thought that it will mark a distinct step in advance of what has so far been accomplished in this line, and hence its possibilities are creating considerable interest in the radio world.

Wireless to Aid Mail 'Planes

The Post Office Department has contracted for the erection of three high-power radio stations, the first of a chain of wireless communicating centres in various cities to be used primarily for the direction of mail-carrying airplanes handicapped by fog.

Stations will be established at Bellefonte, Pa., and Cleveland, Ohio, with a third at some point on Long Island or at Newark, N. J. Appropriations for them already are available. Others will be erected at Washington and Chicago as soon as Congress provides funds.

Each station will be equipped with steel towers 200 feet high and 300 feet apart and will have a range of approximately 400 miles to mail airplanes and approximately 700 miles between stations, the difference in range being due to the lesser sending ability of airplane wireless equipment.

Establishment of the radio stations will enable the Post Office Department to maintain communication between cities having air post delivery independent of telegraph and telephone services in the event of a disruption of service by storms or other causes.

Wireless and the Hidden World of Vibrations

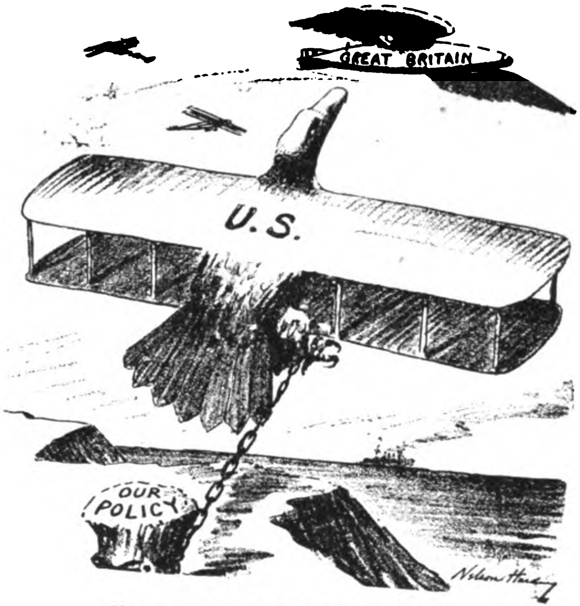
That communication with the dead may be made as commonplace a matter as is wireless communication with a person in Europe at the present time, was the remarkable statement made by Dr. Frederick Finch Strong, of the Krotona Institute at Hollywood.

Experiments have been made there, it was announced, demonstrating the methods which, when further extended, will accomplish this amazing result.

The Krotona experiments give rise to the hope that a technique, whereby new forces and kinds of matter may be revealed.

A sort of transformer process for the dull human senses is being worked out in the hope of proving by means of actual communication with the dead the theory held concerning the continuity of life after death.

One experiment which leads to the belief that any number of things may be camouflaged under a kind of color which makes it impossible for the eye to detect is with ultra-violet rays. Rare minerals, which respond to certain wave lengths, take up and transform them so that they become visible.



Yes, American Aviation Is Looking Up.
—Harding in the Brooklyn Eagle.

Playing Checkers by Wireless

A game of checkers by wireless has been played by two Delaware men, who flash their moves back and forth through the air between Wilmington and Greenville, Del. They are Fred R. Fooding of Wilmington, an official of the Delaware Bank and a licensed radio operator, and William Anderson of Greenville, a student at Delaware College.

The first game of the series lasted an hour and a half. At the end of the period each player had six men on the board. As each player flashed his move on the checkerboard to his opponent he made the move on the board in front of him, which was duplicated by his opponent.

This item is contained in current news, without any explanation, however, of how the ban on transmitting was overcome.

Marconi International Cable Code

IT is announced that the Marconi international cable code, being published in parts of the United States and Great Britain as rapidly as completed, will, for the first time in history, permit people of nine languages intelligibly to communicate with each other without need of translators. The languages to which the code is adaptable are English, French, Spanish, Portuguese, Italian, German, Dutch, Japanese and Russian. Since the code includes phrases of commerce, law and finance likely to be used, however technical, it will be very voluminous and will, for practical purposes, far surpass Esperanto or any other artificial language for international use. The code words will be the same, but, of course, there will be necessity for a book for each of the nine languages. It is said that hundreds of business experts and linguists have been engaged for three years in preparation of the code, and it has been called "the concentrated essence of a lifetime of code study and compilation."

Not only can an American business man, by consulting the English code book, send a code message to a Spanish merchant, which the latter can immediately transcribe by looking up its meaning in his Spanish code book, but the misunderstandings so common in the translation from one language to another will be obviated. The message will be concise and unequivocal to the Spanish as well as to the American. It would be hard to overestimate the advantage that such direct communication will be in facilitating international business.

Marconi took a gigantic step in annihilating distance and bringing nations together when he completed the commercial wireless. The international cable code provides one of the greatest facilities for making it effective. There are other changes, in the interest of better service, such as a condensed manner of sending figures and a letter combination code that permits the sending of two words for the usual cost of one.

Conquering Fog by Means of Wireless

GUGLIELMO MARCONI'S new invention for the purpose of protecting vessels during a fog was discussed recently at the annual meeting of the Marconi International Marine Communication Company, Ltd., in London. Godfrey Isaacs said:

"This new discovery provides a means whereby a ship in the densest fog may discern the approach of another ship, provided that that ship be also fitted with this apparatus, at the same time giving an approximate idea of the distance of the approaching ship. We are at present engaged in giving commercial shape to this new apparatus, and as soon as possible its value on board ship will be demonstrated. We have great hopes that by this means all risk of collision at sea during the thickest fogs will be eliminated, to which end, of course, every ship would have to carry the apparatus, for it stands to reason that if a great liner were fitted and a small tramp were not, the danger of collision and the loss of one or the other, or both, of the ships might result.

"Inasmuch as this new device should provide means of disposing of that which is so great a danger in misty and foggy weather, it is not unlikely, we think, that every ship which goes to sea will be eventually fitted with this new installation, and we shall all be spared the harrowing accounts of the terrible losses which from time to time it has been so distressing to read in the daily press resulting from some terrible collision at sea."

Wireless Between U. S. and Germany Resumed

WIRELESS communication with Germany has been resumed in a limited way by the American government. Business communications between American houses and their agents in Germany are accepted in New York at 44 Whitehall Building, and other points where the navy has district communication officers for transmittal to the trans-Atlantic wireless stations at the Navy Department here and at Otter Cliffs, Me., where they are dispatched to the receiving station at Nauen, Germany. Similar communications are dispatched from Nauen to the United States stations. Press dispatches to the extent of 500 words from this country and a similar number of words from Germany are also accepted daily.

British Government Pays $2,950,000 to Marconi Co.

AN AWARD of £590,000 ($2,950,000) damages was given to Marconi's Wireless Telegraph Co., Ltd., in a suit for breach of contract brought against the British government. The contract was in connection with the construction of the Imperial Wireless System.

The Marconi Company claimed it was entitled to £7,180,000, basing their claim on a provision in the contract that it was to receive royalties amounting to 10 per cent on the gross receipts from the stations for the entire period of the contract, which was to have run for twenty-eight years. The government claimed the damages payable to the company amounted to £50,000.

Wireless on All Ships Over 150 Feet Long

THAT all passenger ships more than 150 feet in length entering or leaving any port or harbor in the United States shall be equipped with wireless is provided in a bill introduced in the House at Washington by Representative Britten, of Illinois.

It is provided also that all United States Coast Guard stations shall be equipped with wireless.

Increased Earnings of English Marconi Co. for 1918

MARCONI'S Wireless Telegraph Co., Ltd., reports for 1918 a profit of $1,989,500 against $1,919,000 in 1917. Dividends on the ordinary shares were increased from 20 to 25 per cent and on the preference shares from 17 to 22 per cent. General reserve was increased by $750,000 to $7,250,000. Shares of associated companies are shown in the balance sheet at a cost price of $6,825,000, compared with a present par value of $11,730,000.

Energy Transmitted on Wireless Waves.

WIRELESS telegraphy and wireless telephony, now commonplaces, suggest the possibility of transmitting energy by wireless waves. A Roumanian engineer, M. Constantinesco, has been experimenting in England with a method that seems novel.

He uses a tube filled with water or some such liquid in which vibrations of the nature of sound waves are produced at one end and the energy is reconstructed at the other end in a mechanical form. The details of the apparatus are kept secret, but Constantinesco's researches have been financed by the British government, and it has already been applied in the mechanism that stops the discharge of bullets from the rapid firing gun of an airplane each time that the blade of the propeller passes before the muzzle.

Wedded by Wireless While Flying in Airplanes

MISS EMILY SCHAEFFER of Sea Gate, L. I., and Lt. George Burgess of Brooklyn, were the principals in a wedding ceremony that featured the second of the two Police Field Days held at Sheepshead Bay. They flew in a plane piloted by the groom who is an aviator attached to the Mineola forces. In the second plane the Rev. Alexander Wouters of the Edgewood Dutch Reformed Church, the first real "sky pilot," flew, with Lt. Eugene Barksdale, the best man as pilot. A long streamer of bunting indicated the bride's plane.

Dr. Wouters conducted the service with the aid of a wireless telephone. The bride and groom were fitted with telephones too. Gov. Smith and Mayor Hylan had receivers, and there were thirty-two receivers for that many of the bridal party in the grand stand.

Besides that, there was a megaphone-like do-dad in front of the centre of the grand stand from which the voices of the contracting parties and of the minister issued. More than 100 persons, who were crowded round, probably heard the voices from this instrument.

Mrs. Burgess, who is 26 years old, the same age as her husband, now a radio instructor at Mineola, tells a thrilling tale of how she met Lieut. Burgess.

"I met my husband, Lieut. Burgess, about six years ago when I was canoeing with a girl friend. He was then the assistant manager of the radio station of the Marconi Wireless Telegraph Company at Sea Gate. The canoe suddenly pitched, as canoes do, and my friend was thrown into the water. The lieutenant saw the accident from the shore and came to our aid in a boat. He rescued my friend and of course we thanked him and our acquaintance began.

"I am interested in the radio code and understand it. When we talked over our wedding, it was suggested that we get married in an airplane by radiophone to demonstrate its wonderful possibilities."

Big Danish Wireless Station

OFFICIAL announcement in Washington that Denmark is making plans to open wireless communication between Copenhagen and the United States, has been made by the Danish Legation. This statement has been made public:

"Information to the effect that regular wireless connection has been established between Denmark and Great Britain has just been received by the Danish Legation here. Plans are now being worked out by the Danish Ministry of Traffic for erecting a great trans-Atlantic radio station near Copenhagen which will put Denmark in direct wireless communication with the United States.

"Danish newspapers complain that their telegrams for some time have been greatly delayed because of the crowded cables. The Danish papers express the hope that the still important plan for a great trans-Atlantic station will soon be realized. The Danish press is anxious to get into direct communication with America so as to be able to obtain news from over here at first hand and at reasonable rates.

"The Danish wireless station at Lyngby is at times able to hear the American station at Arlington talk to Rome, but is not powerful enough to send messages over the Atlantic. The plans now under consideration by the Danish government call for the erection of a trans-Atlantic wireless station."

Postal Wireless Service Throughout British Empire

POSTAL wireless service, to extend throughout the British Empire, has been provided for by the House of Commons in voting 170,000 pounds for the project. The first stations will be opened between England and Egypt. The service may begin by the end of the year.

Eiffel Tower Revives Ancient Custom

AFTER the peace treaty had been signed by Germany's representatives in the Hall of Mirrors at Versailles the Eiffel Tower wireless station sent broadcast the massage "Fermez les portes" ("Shut the doors"). The phrase, as many will understand, was suggested by the fact that when peace was declared in ancient Rome the doors or gate of the Temple of Janus were closed.

Lieut. Durrant of the R-34 Describes Wireless Equipment

LIEUT. REX F. DURRANT, wireless operator of the R-34, speaking of the radio apparatus used during the trans-Atlantic flight, said:

"We had the wireless direction finder on board, known as the maximum method. We had a range of 300 miles. We got very good bearings on Cape Race. All the Canadian wireless compass stations helped us a great deal in our navigation.

"We had a main transmission set using continuous wave with a range of 1,200 miles and a wireless telephone with a 100-mile radius. We also had an auxiliary continuous wave set and an emergency spark set. All these sets functioned perfectly during the voyage.

"We were never out of wireless touch up to the time we passed Newfoundland. We were in direct constant communication with Clifden, Ireland. We were in touch with the British Air Ministry every two hours. We held the Air Ministry wireless station on top of the Hotel Cecil in London half way across the Atlantic. In mid-ocean we were in direct communication with Clifden, Canada, and the Azores at the same time. We carried 400 feet of trailing aerial, for use on all the sets except the direction finder, which was worked by coils.

"The small spark set was excellent. Cape Race read it at 300 miles, although it had only one-tenth of an electric horse power.

"As a result of my experience on the voyage I am designing a larger coil for the direction finder set on these ships. Also, as a result of my experience it has been proved beyond doubt that continuous waves will be the future means of wireless transmission."

Marconi Wireless Rig on Yacht

THE yachts in the Long Island Star class in the annual race to Captain's Island and return included a Star boat with the new Marconi rig, so called because the method of arranging stays makes it resemble the mast of a wireless station. It is the first time that the righ has been put on a boat of this class, and the innovation was watched with the greatest of interest by all yachtsmen.

Donald Cowl is the Corinthian who is trying out the innovation. The yacht that he has altered was formerly the original Little Dipper, the property of G. A. Corry.

Distinguished Service Medal awarded in the name of the President by Gen. Pershing to Lieut. Col. Krumm for "exceptionally meritorious and distinguished services," due to "masterful ability and exact scientific knowledge"

Lieut. Colonel Louis R. Krumm

The famous French decoration, the Legion of Honor, conferred upon Lieut. Col. Krumm and establishing him among the few American officers who have been admitted as Chevaliers to the century-old order founded by Napoleon

The Authors of Wireless in the A. E. F.

Colonel Krumm is best known to wireless men as Chief Radio Inspector, Bureau of Navigation, Department of Commerce, a position which he has held since 1912. He has degrees of mechanical and electrical engineering from Ohio State University and for seven years served as an electrical engineer, Signal Corps. He was commissioned a reserve Captain in this branch of the service in May, 1917, and within three months was promoted to Major, sailing for France, Sept. 27, 1917. His elevation to the rank of Lieutenant Colonel preceded the Armistice by two weeks, recognition of efficient direction of the Radio Division during the entire term of his service in the A. E. F.

Captain Willis H. Taylor, Jr.

Captain Taylor, a graduate mechanical engineer of Stevens, received his reserve officer's commission as 1st Lieutenant, Signal Corps, two months after war was declared. For six months he was assigned to recruiting for the radio branch, going overseas in December, 1917. Four months later he became assistant chief of the Radio Division, A. E. F., and thirteen months after his enlistment was promoted to the rank of Captain. General Pershing mentioned him in a citation for "exceptional and meritorious services" as the officer responsible for the co-ordination of the work of the other Sections in the A. E. F. and maintenance of liaison with the Radio Division at Washington

Wireless in the A. E. F.

First Authentic Account of the Organization of the Radio Division of the Signal Corps and an Inside View of the Great Obstacles which Americans Had to Overcome

By Lieut. Col. L. R. Krumm
Officer in Charge Radio Division, Signal Corps, American Expeditionary Force
and Capt. Willis H. Taylor, Jr.
Co-ordination Officer, Radio, Division, Signal Corps, A. E. F.

IT HAS been a commonplace saying in all articles relating achievements of the Great World War that it was a contest of science and skill.

The Authors in the headquarters of the Radio Division at Tours, France

In no branch of an army's activities is this better exemplified than in the utilization of the wireless method of communication. Thus the prepartion of articles recounting the work of the U. S. Army Signal Corps and its use of radio telegraphy and telephony for military purposes has presented the problem of selection from superabundance, leaving the authors confronted by the difficulty of picking out from the mass of material available those things which will best reflect the magnitude of the task and its accomplishment. In this and the succeeding articles of the series there will be set down without embellishment those historical and technical facts which appear to be of most interest. not alone to the radio profession but also to the general public.

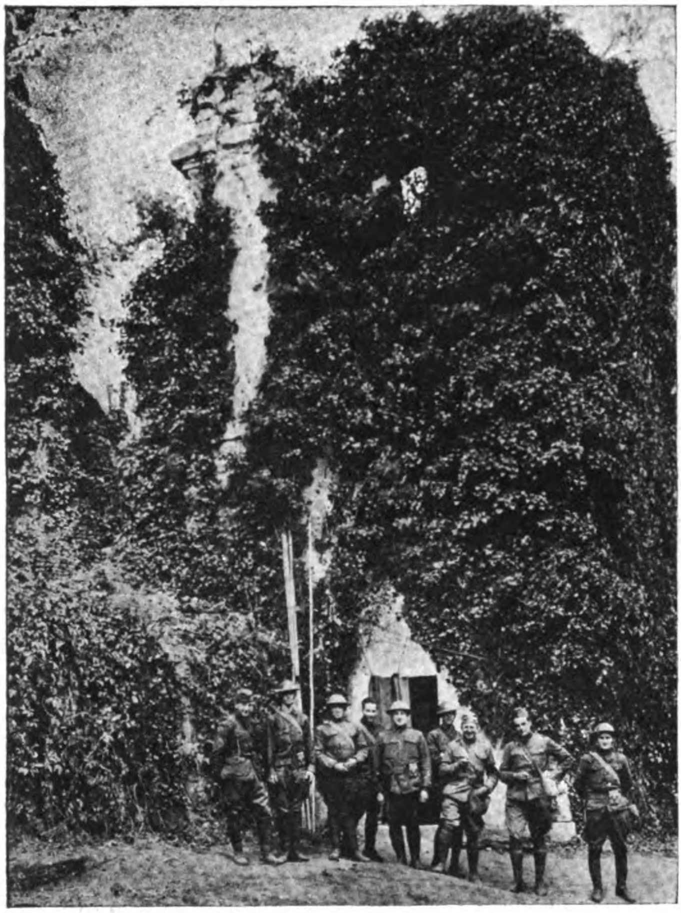
The absolute unpreparedness of the American Army for a war of the magnitude of this one is a matter of universal knowledge; nowhere was it better indicated than in the radio equipment and personnel available to the Signal Corps when this country entered the war. Only two types of military radio equipment had been developed and put in use; these were the ¼ kw. 500 cycle quenched spark pack set, adapted to be transported on mules and provided with a hand driven generator, and a 2 kw. 500 cycle quenched spark automobile set. Both were fairly good equipments of their types, quite satisfactory for warfare such as might be encountered on the Mexican border. Unfortunately neither of these sets was suitable for use in the European war, so that it may be said that the U. S. Army, at the time of the declaration of war against Germany, had no suitable radio equipment for its signalling troops. This was demonstrated. Some of these sets were sent to France, but were never used for transmission during operations. Practically all the radio equipment used by the American Expeditionary Forces was of French manufacture, for the development and production of equivalent material in the United States on a quantity basis was not accomplished until about the time the armistice was signed.

It is interesting to note that after the armistice, an effort was made to utilize one of the pre-war 2 kw. spark tractor sets at Spa, Belgium, to provide communication for the American section of the Armistice Commission which had its headquarters at that point, but its use caused such interference with the undamped wave sets of the stations of the other allied armies as to make the American army decidedly unpopular from a radio standpoint. The station had to be replaced by an undamped wave set, the sharper turning of which permitted the simultaneous operation of the different sets in that vicinity. Spark sets having more than 100 watts transformer input were decidedly *de trop* with the Allied Armies in France, and the extensive use of vacuum tube undamped wave transmitters—even with the very front line troops—was decidedly contrary to the previous practices or principles of our Signal Corps. In a later article a detailed description of these sets will be given; at this time it will be sufficient to say that the suitability of this type of equipment to meet the trying conditions of war communication was most thoroughly demonstrated.

The many special functions of the radio personnel will also be described later, for it should be observed here that the diversity of employment was developed to a point which it is probable that few officers of the Army before the war had thought of, much less provided for.

Brigadier General Edgar Russel, Chief Signal Officer, American Expeditionary Forces, who arrived in France in June, 1917, had seen long service and distinguished himself as an officer in the Signal Corps, having served in Mexico and the Philippine Islands. He was well aware of the inadequacy of our Army's radio personnel and equipment and realized that it would not be easy to overcome the deficiencies. The problem of personnel was similar to that of all other branches of the service. Men could be given their initial and fundamental training in the United States contemporaneously with the training of the other services. But equipment in enormous quantities and especially constructed for war uses had to be provided from the beginning, and radio equipment of this character was not available in the United States. There were experienced American manufacturers to be called upon, but their capacity was limited and the large requirements of the Navy demanded added output. It soon became evident to General Russel that his supply must come from one of our Allies. Soon after his arrival he arranged with the French authorities to obtain from them the necessary radio and T. P. S. (ground telegraph) equipment for our troops until such time as these could be supplied from the United States. His foresight in this direction will be further emphasized in the story of supply.

The French Army made greater use of undamped wave sets than any of the armies. The probable reasons for this may be of interest. Prior to the war it was a well-known fact commercially that the German spark sets were superior to the French spark sets. At the beginning of the war, so French officers told us, the German Army's radio equipment and communication was considerably superior. The French, realizing the necessity for better equipment, wisely appreciated the possibilities of vacuum tubes for transmitting and receiving; then decided, therefore, that the use of spark sets would be restricted to those types suitable for front line work, where simplicity is the controlling factor. For all other wireless communication they adopted undamped wave sets which used the same type of three-element tube for both transmitting and receiving, thus greatly simplifying their supply problem.



The very old and the ultra-modern joined hands in wartime when a divisional wireless station was installed by American men of the Signal Corps in this ancient chateau, erected about 500 A. D.

Now as to the importance of wireless. Radio telegraphy, it must be remembered, is essentially the emergency communication method of the Army. In trench warfare where positions were permanent and troops did not change their lines—in some cases for years—wire communication was preferred and desired; very complicated wire systems were installed and maintained even under conditions of greatest difficulty. But even in these positions, radio stations were provided to take up the burden of maintaining communication in time of heavy shelling, when the wires were broken and could not be repaired. In mobile warfare, on the other hand, radio immediately demonstrated its superiority over all other means of communication and those officers best qualified to judge are convinced of its even greater utilization in future wars.

Radio operations take on the general character of the other activities of an army in that, in a general way, they can be divided into offensive and defensive classes. The use of this classification in regard to communication may seem strange, but it can be easily explained. Offensive radio may be considered as its use in establishing and maintaining communication during battles or other operations in the same manner as the telephone and telegraph or visual signals are used. The superiority of radio at such times is at once evident, for any method of communication requiring wires is too difficult to erect and is entirely too vulnerable to injury in the deluge of artillery projectiles hurled in modern battles.

The one fault in wireless communication which has not been practically overcome to date, although the problem is now under consideration in many laboratories, is that it cannot easily be made a selective or secret means of communication. The fact that all radio work can be heard by the enemy brings us to the so-called defensive radio. If the enemy can overhear your radio stations, he is equally handicapped by the fact that you can hear his, and therein lies your opportunity to profit by the old adage that "forewarned is forearmed."

In the mobile warfare that brought us the victory, ground telegraphy proved to be practically worthless and will probably be displaced in future wars by small wireless sets using loop antennae.

Wireless equipment for tanks was one of the problems that long defied solution. A set was finally developed that makes possible communication with the post of command and co-operating airplanes.

As might be expected, military communications are never transmitted in plain language. Code is always used. Cipher has been discarded because it requires too much time to encipher a message for transmission and because it can be accurately deciphered by mathematical methods.

Phrase code was used principally, and was frequently changed. In spite of all precautions, however, one of the main sources, if not the main source, of intelligence regarding the enemy's projected operations lay in the interception of messages by the Radio Section (Intelligence) of the Signal Corps. These Radio Sections (Intelligence) were the defensive radio organizations of the army. Whereas each combat division numbered among its troops a Field Signal Battalion included in which was one company of 75 men, assisted by certain men of the outpost company and some from the infantry signaling detachment, which was expected to maintain the radio communication within the division, the Radio (Intelligence) Section was not attached to any unit smaller than an Army and was expected to cover our entire front and operate wherever needed. In addition to the duty of intercepting messages from ground and airplane radio stations of the enemy, these men were charged with the responsibility of locating them by direction finding or goniometric stations, noting the channels of communication and every characteristic that might tell us how many and what troops were opposing us, and their probable plans for our future destruction. How the plotting of the location of stations and channels of communication clearly indicated the enemy's organizations is a fascinating subject; the methods used will be explained in a future article, as well as the counter efforts of the enemy to confuse our radio intelligence operators.

Included in the duties of the Radio Section was the operation of the so-called Listening Stations. These stations were intended to intercept all messages from the enemy's T. P. S. (ground telegraph) stations and all grounded telephone or telegraph lines. Grounded lines were never intentionally used by any army in the latter part of the war, but no electric circuit could be maintained in a proper state of insulation and balance which would prevent our listening stations intercepting the messages carried thereon if it was anywhere near us, as was the case during the position or trench warfare stage.

Low frequency amplifiers were connected to long leads running to grounds placed as near the enemy lines as possible. The stations were necessarily installed in dugouts within a few hundred feet of the front line trenches and the experiences of the men who were assigned to operate and maintain these stations were among the most heroic of the war. As the effectiveness of these stations depended upon the nearness of their grounds to the enemy's wire lines, our men when carrying these ground wires over into the enemy's territory, performed some of the most daring deeds of the war. One of the subsequent articles of this series will tell how these expeditions were carried out; how one of our men actually went over into the enemy's trenches and connected to important lines of telephone communication, enabling us to intercept Hun conversation for several days before it was discovered.

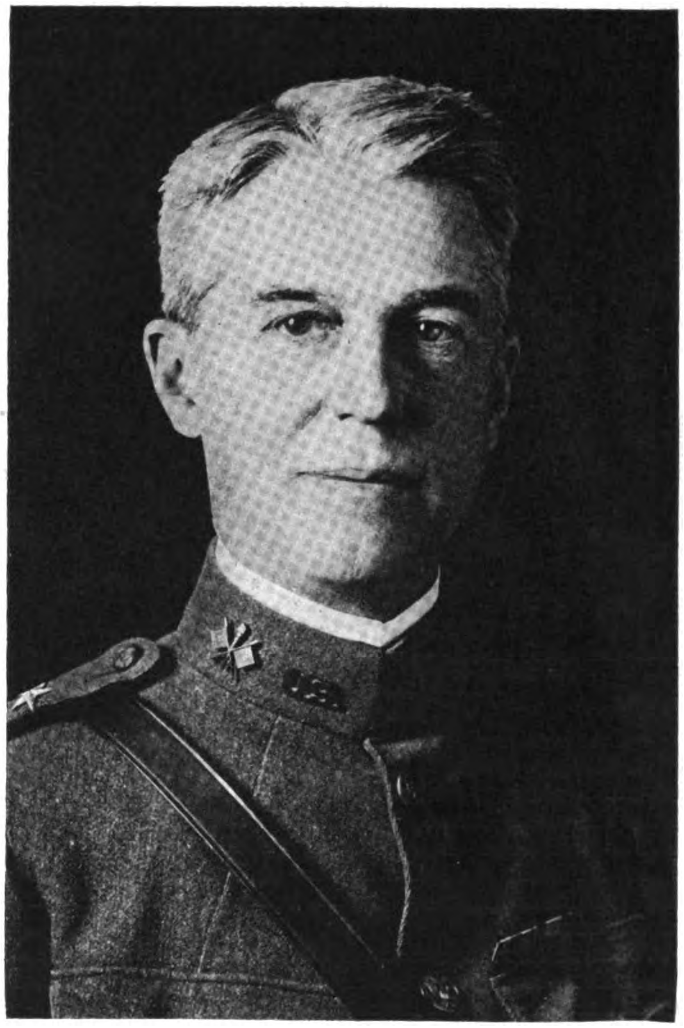
This ground telegraphy—developed by the French during the war and known to them as the T. P. S. (Telegraphie par Sol)—was made practically possible by the development of amplifiers utilizing three-electrode vacuum tubes. The transmitter consists essentially of a 50-watt induction coil, the primary circuit controlled by a telegraph sending key in series with the storage batteries carried as the source of power. The secondary of the induction coil is grounded through wires carried to grounds about 100 yards apart. Transmission is effected by the lines of flow of current between grounds which are intercepted by the receiving station. Audio frequency amplifiers, such as were used in the listening stations, were used for receiving, the receiving amplifier being also connected to ground plates separated by distances of 100 yards or more. It is a very crude means of communication, because of its efficiency being so dependent on local conditions; its use therefore, was necessarily limited, but in trench warfare of fixed positions it served very well in many places of favorable terrain.

One of the main sources of intelligence regarding the enemy's projected operations lay in the interception of messages by the defensive radio organizations of the U. S. Army.

So-called listening stations were installed in dugouts within a few hundred feet of the front line trenches; the experiences of the men who were assigned to this duty were among the most heroic of the war.

In the mobile warfare that brought us the victory it proved to be practically worthless and ground telegraphy will probably be displaced in future wars by small but efficient portable radio sets using loop antennae. In open warfare T. P. S. stations soon lost track of their relative positions and consequently lost their communication when endeavoring to establish a station in a new position. One of the greatest defects in this means of communication was found in the necessity for the long ground leads which were difficult to maintain, and the requirement for ground circuits of the receiver to be in such relative position as to intercept a maximum of potential and current. The system was never reliable for more than 2,000 yards, and then only under the most favorable conditions. Where a river or other low resistance path for electricity intervened between the transmitting and receiving station the distance was reduced proportionately. But for several years T. P. S. was the main reliance of the French, and for a time of our own troops for front trench line emergency communication. In an attack at Seicheprey our troops in repelling the attack used this means of communication, whereas the Boche carried over with him a portable radio set of the spark type and also a telephone line which was extended with the advance. His reasons for carrying the radio seemed rational, and judging from the telephone circuit, he evidently expected to occupy the position permanently. The fact that both means of communication fell into our hands before the fight ended indicated a miscalculation on his part.

The enemy also used ground telegraphy in the front trenches which made the establishment of our listening stations essential, so that these could fulfill their intelligence-gathering function for this means of communication exactly as did the radio intercept stations in gathering the enemy's messages from the air.



Brigadier General Edgar Russel, Chief Signal Officer, A. E. F., who early in the war realized the inadequacy of our army's equipment of apparatus and personnel; his foresight contributed largely to the eventual success of the American signalmen

Ground telegraphy (T. P. S.) messages were coded of course, but no code or rules or regulations have ever been devised which will prevent indiscreet conversation over the telephone. German efficiency experts evidently failed to devise any means to prevent these leaks and German conversations were constantly overheard. This required that all of our men employed in listening stations should understand German readily, as well as have the ability to record telegraphic code. As a matter of fact ground telegraphy sending is necessarily slow; interception of the code was found to be much easier than the determination whether a faint gutteral voice from the enemy's line was demanding more ammunition or more men. At first we endeavored to get German-speaking radio operators, but the supply was limited; so we selected men who understood the German language and taught them code at the same time when we were coaching them in the use of the equipment and the German military phrases they might expect to overhear.

Another, and possibly the most important function of these listening stations, was the so-called "policing" of our own telephone lines. We knew that alert German ears were also pressed to receivers of their listening stations and could overhear indiscreet language on our lines. Code names were provided for all places, units and common subjects of conversation over our lines, but in the press of action—and, sometimes, even in the quietest hours—our officers failed to realize the danger of using plain English and neglected to obey the orders and instructions forbidding its use. Our listening stations were constantly on the alert for these indiscretions and many a high ranking officer was embarrassed by having a verbatim report of his careless words handed him a few minutes after he had completed a telephone conversation.

A radio intelligence detachment was housed in this old barracks when the Boche became suspicious and put over a few shells; the soldier is standing in one of the resultant holes

As has been stated, a perfectly balanced insulated metallic telephone circuit cannot be overheard, so that the condition of the line was also revealed by these stations and immediate steps would then be taken to repair the circuit in question.

We learned how the enemy appreciated the potentialities of our listening stations when our troops captured some German trenches in the latter part of the war. Their telephones were sealed up and captured orders indicated that these phones were only to be used in the greatest emergency; the officer breaking the seal was required by these orders to send in a written report as to the necessity for its use. In some parts of the line, as far back as two miles from the front, German telephones were found to be sealed up, indicating a respect for our listening stations exceeding our own, for we did not expect them to be over that distance.

All of the various fields of military radio activity so far outlined were practically a sealed book to the American Army before its entrance into the war and the gigantic undertaking of training and equipping the personnel for this work represents one of the greatest achievements of our army. Lt. Col. Krumm sailed for France in September, 1917, with as little real knowledge of the task before him as many of his readers. Samples of some of the French radio and T. P. S. equipment had been shown to different officers here under injunctions to observe the greatest secrecy, although many of them embodied no new ideas.

No real information of how the equipment was used or the scope of the work was forthcoming, especially in regard to the radio intelligence work. This phase of communication was always kept from general discussion in our own army, even after we had been in the war for a long time. It was considered that the less the enemy knew of our activities, the less preventative measures he would take against them. Few, if any, officers or soldiers who were not directly concerned in the intelligence work were aware of the fact that much of the information that guided their operations had been obtained by the Radio Section. The only other sources of information comparable with it were the prisoners captured from the enemy. By the same token, the less our men knew of our work the less they could tell should they fall into the hands of the Germans. If the location of a listening station became known its effectiveness was immediately destroyed by the counter measures taken against it, so that many a doughboy noted the strange equipment in a dugout in his sector without knowing its purpose.

The Germans are generally given credit for first discovering the possibilities of these ground listening stations and the precautions they took at the outset to keep the men assigned to this duty from coming in contact with other soldiers and discussing their work, are interesting. They were given extra pay, their meals were brought to them and they were pampered in every way and they were evidently the most exclusive branch of service in the German army. Once the work became known to the Allies, though, this exceptional treatment was discontinued and these "cellar detectives" were treated like the rest of their army.

In the early Spring of 1917, a French delegation headed by Dr. Abraham, the well known scientist was sent over to the United States to demonstrate the wireless and T. P. S. equipment used by the French Army, but the information was treated more as of scientific interest than as vital for general distribution among those who would later be called upon to use it in the field or to guide them in the manufacture of similar equipment in this country. Specimens of the apparatus in use by the French Army were furnished, which were to be used to guide the development and production in this country of equivalent material so that the U. S. Army could later be entirely independent of European supply. The fact that this desirable and, if the war had continued, possibly essential condition was not attained has already been told. The French Government had promised, meanwhile, to provide all the necessary radio equipment for the American troops until such time as production could commence in the United States, and this they were able to do until the drive of the Germans in March, 1918, when the rapid advance toward Paris resulted in a loss to the French of enormous reserve supplies of radio equipment. They were brought face to face with the urgent necessity of re-equipping their own men without considering ours. Added to that, it was these dark days of the war that brought on the influx of American troops at the rate of ten thousand a day—figures entirely beyond the calculations of the French when they agreed to furnish us the necessary radio equipment. Our own material had not been satisfactorily developed or produced in quantities in the United States and we were unable to look there for relief. Of those who watched the progress of the battles around Chateau Thierry, none were more harassed by anxiety than the officers who were concerned in the problem of obtaining radio equipment for our troops.

With the turning back of the Huns on their tracks toward Germany and the removal of the threat to Paris, where most of the radio factories of France are located, the French Army authorities regained confidence and the supply of wireless equipment was resumed. The British were never able to furnish us any amount of apparatus and it was inadvisable to use different types, which would complicate the supply and maintenance of equipment as well as the training of the personnel.

Tours of duty with both the French and British Armies had indicated to Lt. Col. Krumm that the French equipment was equal to the British and more suited to the methods of the American Army, so that no concern was felt as long as it was possible for the French Army to provide us with radio material. Nor was there any doubt as to the ability of our men to handle the apparatus; the standard of operators of this country is as high as that of any of the Allies, and events proved our faith in our men to be well founded.

It might be well at this point to acknowledge the debt this country owes the amateur radio operator for the work he did in the Army. In his position as Chief Radio Inspector, Bureau of Navigation, before the war, Colonel Krumm had looked upon the amateur radio man somewhat as an omnipresent American evil, like mosquitos. But it was these amateurs who were among the first to respond as volunteers for the Signal Corps, and his respect for them increased immediately and it has never since abated. Subsequently, their excellent work in the field under the most discouraging circumstances, under the most trying and uncomfortable conditions, has earned them a place in history. Too generous appreciation cannot be recorded of those who fostered and cultivated this invaluable source of supply of American radio operators, probably without ever realizing just how well they had planted the seed. Allied officers often spoke of this phase of our personnel supply and regretted the interest in radio matters had never existed in amateurs of their countries, as it had in ours.

The value of real enthusiasm for his work—an outstanding characteristic of most amateurs—was particularly shown in the radio intercept stations. The ideal operator for this work is one who never for one instant ceased to hunt for enemy stations with his receiver. He must record a jumble of mixed letter groups which to him mean nothing. A mistake of one letter in a three letter group will probably throw the decoders entirely off the true meaning of the message. He must record the wave length used and get all the prefixes so that the stations communicating can be determined. But above all he must instinctively note every personal characteristic of the senders "fist," or transmitting methods. Many a German organization has been traced all along the front by some peculiarity of a radio operator attached to it, who did not realize the necessity of absolute uniformity in sending. To detect these things the intercepting operator must never let down the intensity of his interest. The enthusiasm of the amateur for his work was one of his biggest assets.

When we entered the war the U. S. Army had in use only two types of wireless equipment; neither of these sets could be used in France.

Officers of the line did not take radio seriously. One whose unit had been isolated in the Argonne sent back this wireless message: "All communication cut off. How shall I keep in touch with you?"

The various fields of usefulness found for wireless were practically a sealed book to the American Army; the gigantic undertaking of training and equipping the personnel for this work represents one of the nation's greatest achievements.

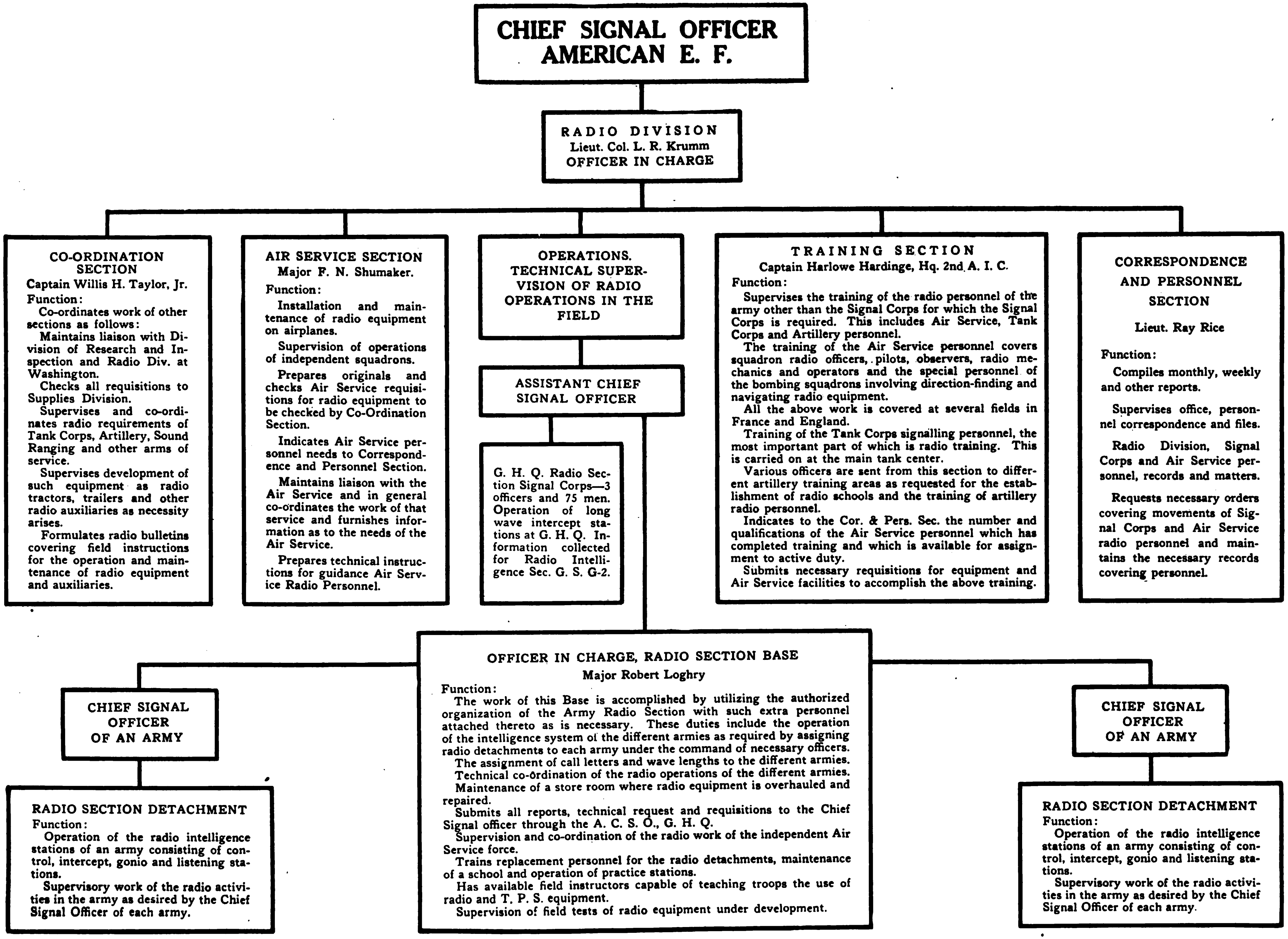
Unfortunately for the Army, a very large proportion of the commercial and amateur operators joined the Navy at an early date, so that the supply of expert men available was soon exhausted, and the many additional men required had to be trained. This branch of our activities holds many points of interest and will be covered more fully at another time.

Officers of our Allies often indicated their belief that our men were notably successful because they were fresh in the work, but they expected when we had been in the war as long as they had, that we would also lose our enthusiasm and effectiveness. This no doubt was true to some extent, and it applied in a minor way to all branches of the service, but on the whole the American Army can look back on the work of its radio personnel with genuine and particular satisfaction.

When a man has had three or four years of operating under constant shell fire all the glamour of war disappears and the daily communication duty becomes a grind. This view was illustrated one day when Colonel Krumm visited one of the French artillery receiving stations to which range corrections from airplanes were wirelessed. As the visitor was regretting that his limited knowledge of French prevented him from questioning the operator, the latter in good English informed the American officer that he knew him in New York. The operator then explained that he was a New York boy of French parentage and had joined the French Army three years before, resigning his position as a Marconi operator on a ship sailing out of his home port. Commercial operating had never been like his present job, he readily admitted, and added that he was "fed up" with the war thing. This was in the Champagne country during the disheartening days of the Fall of 1917. Our men never experienced the depressing effect of the discouraging battles as did the Allied operators—so it is fair to assume that the Allied officers were right in their estimate of American effectiveness.

This listening station in the Vosges is typical of those maintained so secretly by American wireless men that doughboys in the same sector never learned the purpose of the strange equipment

Captain Taylor joined the A. E. F. in December, 1917, about the same time as the first detachment of about seventy expert operators arrived. The Radio Section (Intelligence) of the Radio Division was then organized. The accompanying chart shows the scope of this organization and the duties of the Radio divisions on the day the armistice was signed. On December 8th, 1917, the first radio intelligence stations, intercept and gonio, were established in a French sector. It was considered advisable to operate some intelligence stations in the French position so our men, both operators and decoders, would have an opportunity to work under actual fighting conditions. The radio intercept and goniometric stations were there-



CHIEF SIGNAL OFFICER AMERICAN E. F.

RADIO DIVISION
Lieut. Col. L. R. Krumm
OFFICER IN CHARGE

CO-ORDINATION SECTION
Captain Willis H. Taylor, Jr.
Function:

Co-ordinates work of other sections as follows:

Maintains liaison with Division of Research and Inspection and Radio Div. at Washington.

Checks all requisitions to Supplies Division.

Supervises and co-ordinates radio requirements of Tank Corps, Artillery, Sound Ranging and other arms of service.

Supervises development of such equipment as radio tractors, trailers and other radio auxiliaries as necessity arises.

Formulates radio bulletins covering field instructions for the operation and maintenance of radio equipment and auxiliaries.

AIR SERVICE SECTION
Major F. N. Shumaker.
Function:

Installation and maintenance of radio equipment on airplanes.

Supervision of operations of independent squadrons.

Prepares originals and checks Air Service requisitions for radio equipment to be checked by Co-Ordination Section.

Indicates Air Service personnel needs to Correspondence and Personnel Section.

Maintains liaison with the Air Service and in general co-ordinates the work of that service and furnishes information as to the needs of the Air Service.

Prepares technical instructions for guidance Air Service Radio Personnel.

OPERATIONS. TECHNICAL SUPERVISION OF RADIO OPERATIONS IN THE FIELD

ASSISTANT CHIEF SIGNAL OFFICER

G. H. Q. Radio Section Signal Corps—3 officers and 75 men. Operation of long wave intercept stations at G. H. Q. Information collected for Radio Intelligence Sec. G. S. G-2.

TRAINING SECTION
Captain Harlowe Hardinge, Hq. 2nd A. I. C.
Function:

Supervises the training of the radio personnel of the army other than the Signal Corps for which the Signal Corps is required. This includes Air Service, Tank Corps and Artillery personnel.

The training of the Air Service personnel covers squadron radio officers, pilots, observers, radio mechanics and operators and the special personnel of the bombing squadrons involving direction-finding and navigating radio equipment.

All the above work is covered at several fields in France and England.

Training of the Tank Corps signalling personnel, the most important part of which is radio training. This is carried on at the main tank center.

Various officers are sent from this section to different artillery training areas as requested for the establishment of radio schools and the training of artillery radio personnel.

Indicates to the Cor. & Pers. Sec. the number and qualifications of the Air Service personnel which has completed training and which is available for assignment to active duty.

Submits necessary requisitions for equipment and Air Service facilities to accomplish the above training.

CORRESPONDENCE AND PERSONNEL SECTION
Lieut. Ray Rice
Function:

Compiles monthly, weekly and other reports.

Supervises office, personnel correspondence and files.

Radio Division, Signal Corps and Air Service personnel, records and matters.

Requests necessary orders covering movements of Signal Corps and Air Service radio personnel and maintains the necessary records covering personnel.

OFFICER IN CHARGE, RADIO SECTION BASE
Major Robert Loghry
Function:

The work of this Base is accomplished by utilizing the authorized organization of the Army Radio Section with such extra personnel attached thereto as is necessary. These duties include the operation of the intelligence system of the different armies as required by assigning radio detachments to each army under the command of necessary officers.

The assignment of call letters and wave lengths to the different armies.

Technical co-ordination of the radio operations of the different armies.

Maintenance of a store room where radio equipment is overhauled and repaired.

Submits all reports, technical request and requisitions to the Chief Signal officer through the A. C. S. O., G. H. Q.

Supervision and co-ordination of the radio work of the independent Air Service force.

Trains replacement personnel for the radio detachments, maintenance of a school and operation of practice stations.

Has available field instructors capable of teaching troops the use of radio and T. P. S. equipment.

Supervision of field tests of radio equipment under development.

CHIEF SIGNAL OFFICER OF AN ARMY

RADIO SECTION DETACHMENT
Function:

Operation of the radio intelligence stations of an army consisting of control, intercept, gonio and listening stations.

Supervisory work of the radio activities in the army as desired by the Chief Signal Officer of each army.

CHIEF SIGNAL OFFICER OF AN ARMY

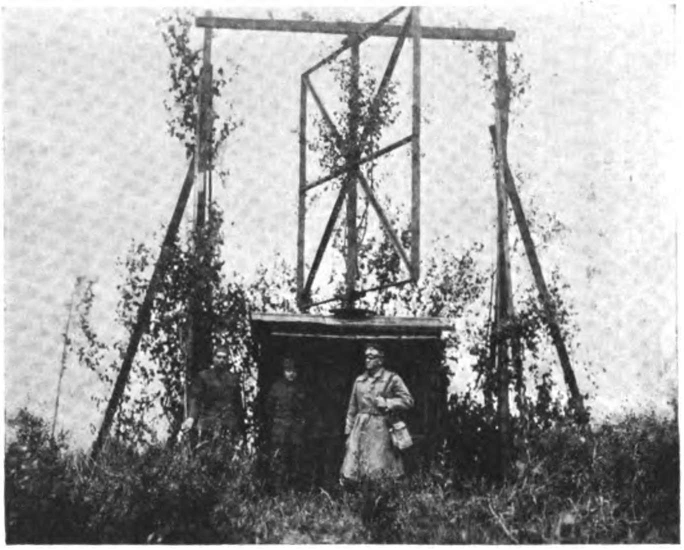
RADIO SECTION DETACHMENT
Function:

Operation of the radio intelligence stations of an army consisting of control, intercept, gonio and listening stations.

Supervisory work of the radio activities in the army as desired by the Chief Signal Officer of each army.

fore established to the west of Verdun in territory held by the French and covered by their own radio intelligence system. Our stations were understood to be practice installations and every assistance was given us by the French to become acquainted with the practical phases of the work. Thus we were pleased and flattered when, within a short time, we received a request from them to furnish copies of all the messages and goniometric readings recorded; subsequently we had reason to know that they were exceedingly grateful for our assistance.

With the entrance of our troops into the line came the real test of our radio communication. The training or practice which we carried on under conditions which appeared to be exactly those of actual warfare seemed advantageous; but how fallacious this idea was quickly developed in the operations. The first troops to go into the line had been given several months' training; the officers had been afforded an opportunity to visit sectors held by the French and English troops and had been in the atmosphere of war for several months before actually participating in it. Later, when our soldiers were arriving at the rate of two divisions a week and were sent into action almost immediately, many of the signaling troops were unfamiliar with the radio equipment and had only a sketchy knowledge of their proper function in the communication system. Troops which went into the line with the British Army, after training with French sets, were provided with British radio equipments. Because of the delay in producing equipment in the United States few of the radio personnel sent over to the A. E. F. were properly trained or prepared to take up their work, in fact, their first knowledge of duties and the equipment which they would use was gained after their arrival in France. This made radio training one of the hardest problems. Yet in spite of the many handicaps nearly all acquitted themselves with credit and the difficulties overcome by the different radio companies of the Signal Corps will make interesting reading.



A camouflaged gonio, or wireless compass station of a type operated by the Radio Section (Intelligence) Signal Corps, in France

Considering the short period of training given our signalmen the results were magnificent; possibly the principal factor in restricting the usefulness of our radio was the ignorance of many American officers as to its limitations and possibilities. The reluctance of our officers to code message was the greatest single handicap. Operators were absolutely forbidden to transmit anything "in the clear" and all messages were required to be handed them in code. So difficult was the enforcing of this requirement that the probable future practice in handling these messages will be to have them coded by the Signal Corps personnel. The failure by line officers to take radio seriously is illustrated by an episode. said to have occurred in the Argonne. An officer commanding a unit which had become isolated sent back the following radio message: "All communication cut off. How shall I keep in touch with you."

Earlier in the article one class of radio operations was referred to as embracing offensive activities, to indicate the use of the wireless telephone and telegraph as a means of communication between the different units and branches of service of an army. This not only includes stations at different infantry battalion and regimental headquarters, brigade, division, corps and army headquarters, and similar units, but also the special radio services of the air service, the tank corps, artillery sound ranging by the engineer corps, and the meteorological service. All have highly specialized requirements, especially the air service.

At the beginning of the war the air service was part of the Signal Corps, which is the communication branch of the army. At that time the wireless communications of the air service were supervised by its own radio division as part of the Signal Corps. Later, when the air service was separated from the Signal Corps and established as a separate service, its radio organization was continued. It was found advisable, however, to centralize the supervision of the radio of the air service in the Signal Corps, and about a month before the signing of the armistice this work was taken over by the radio division of the Signal Corps, so that all radio operations of the army properly came under the supervision of the Chief Signal Officer, A. E. F. Radio equipment for the airplanes engaged in war operations must be governed by the peculiar requirements and limitations of the flying craft, but the major portion of their work is with ground stations. Radio communications between planes in flight and from the ground to the planes was never reliably accomplished, in fact, in the war operations of the air service in France. Radio telephonic communication between airplanes—the goal of the air service of every army and the essential requirement if squadrons or larger bodies of planes are to act as a unit—is a subject which was given preferred attention in the United States. Various articles have been written indicating results achieved in the development of radio equipment for communication between and to airplanes from the ground. The sets developed in this country were received shortly before the armistice; they were being tested out and personnel was being trained when hostilities ended. But the radio telephone was never used by our air service in actual combat.

In the so-called artillery reglage work where the airplane observer supplies batteries and groups of artillery with information indicating the accuracy of their shell fire and the correction necessary to obtain the greatest results, our airplanes were probably as effective as those of any other nation. In this wireless work they used the French spark sets, a very simple and light equipment, utilizing a wind-driven generator mounted on the fuselage with the rotary gap on the generator shaft. A trailing single wire antenna was used.

Airplanes were also used for reconnaissance, supplying information by radio to unit commanders regarding the activities of the enemy, and also in many cases the position of our own line. It must be remembered that in mobile warfare, calling for rapid advances such as marked the last part of the war, many of the units were located in woods or other positions which the commanders themselves were unable to recognize. Airplanes thus became the most accurate source of information as to the location of the advancing lines.

Tank radio was also one of the most interesting and difficult questions which confronted American research experts. No wireless equipment had been devised which would operate from a moving tank. In the British Army the tanks merely acted as transports for the set; it was the practice to drop the set from the signaling tank, establishing it in some protected and suitable place as near the front as possible. The French had experimented with a set using a trailing antenna, but it was found to be unsatisfactory and as far as known never was used in action.

A large antenna cannot be used on a moving tank; it must be small, easily erected and removed. An undamped wave tank set was developed in the A. E. F., so constructed that the radiated wave length was entirely independent of any change in the antenna, which was of the umbrella type consisting of a short pole projecting a few feet above the tank with ribs that could be spread as desired. A sample equipment had been sent back to the United States before the armistice, but had not been put in production and supplied us in time for use. The possibilities of this set cannot be over-estimated, as the mobility of the tanks makes a reliable means of communication absolutely necessary; with an efficient wireless installation they could not only have communicated with their post of command, but with the airplanes working in conjunction with them.

Artillery receiving stations work with reglage airplanes controlling their batteries. Sound-ranging receiving stations were provided to note the radio activities of enemy airplanes, the prelude to their artillery activities. The wireless method was also used in communicating meteorological data, of the utmost importance in the regulation of artillery fire and airplane operations. Weather and meteorological information was sent out approximately every four hours. Spark equipment using approximately the same wave length and spark characteristics as the airplane stations were used for this purpose.

The personnel necessary for all these special radio activities required highly specialized training and this was accomplished as well as time and facilities allowed at many points in France and England. A large school was established at the Air Service training center at Tours, where observation officers were trained in the use of their radio equipment and radio operators and mechanics were developed in large numbers. Captain Harlowe Hardinge, a trained engineer, who had been one of New York's most enthusiastic amateurs before the war, was in charge of the radio school at Tours and the excellent results attained there are largely due to his ability. Other training centers were established for instruction in artillery fire control by wireless, tank radio, and in England a school was to be conducted for the instruction of personnel for the operation of direction-finding equipment, wireless apparatus which enables bombing planes to attain their objective at night and return to their home field.

The debt this country owes to the amateur radio operator in the Army is acknowledged in this article.

These civilians were the first to respond as volunteers and their excellent work in the field under the most discouraging circumstances has earned them a place in history.

Allied officers often spoke of this source of personnel supply and regretted the lack of interest in amateur work in their countries.

The supply of radio apparatus had its special problems. This was an undertaking which necessitated the most careful compilation of advance requirements, so that the ever increasing and overwhelming numbers of American troops might be promptly supplied with the proper radio equipment which would enable them to take their place in the line without delay. To this end all of the production facilities of the French operated in conjunction with the excellent general supply system of the Signal Corps. It should be appreciated that the French were practically unprepared to manufacture radio equipment in quantities sufficient to meet the needs of the French Army, yet the problem was enormously complicated by the wholly unexpected arrival of an immense American Army in an incredibly short period. Considerable readjustment of their manufacturing plans was required to meet this demand. General Ferrie, Chief of the French Military Radio Telegraphic Service, and his staff will always be remembered in this connection for their untiring efforts and co-operation in this difficult task.

Divisional Fiat tractor radio station in operation within ruins to avoid detection

While it was the policy of the Signal Corps not to manufacture any radio telegraphic or telephonic apparatus in France, the equipment purchased had to undergo rigid inspection before acceptance from the French Government. This work required men familiar with all phases of manufacture. Well equipped laboratories were established to provide for this important function, and to conduct the research work necessary in the development and solution of immediate problems. Here, too, was centralized that necessary research which served as the basis of intelligent constructive suggestions forwarded to the United States. In this work the Signal Corps was extremely fortunate to have Major E. H. Armstrong as an advisor on all technical matters. To him may be credited many achievements in connection with the constantly arising difficulties with apparatus and its maintenance, to say nothing of the radio development carried on by him in his laboratory.

The reader has now been given an outline of the great field of endeavor covered by radio men in the A. E. F. That these various activities required specialized methods and equipment is evident to laymen as well as those actively engaged in the art. The succeeding articles of this series will cover each subject in more detail, describe some of the French apparatus used and record some of the many experiences that befell our radio men in the A. E. F. while accomplishing results which should ever remain a source of pride to the whole American people.

(To be continued.)

Lowenstein's Quenched Gap

VARIOUS forms of quenched gap have been proposed heretofore, but they have one disadvantage. If any of the component gap elements have to be removed for repair or replacement, it cannot be effected without disturbing other gap elements in the series, and practically taking apart and reassembling the complete gap structure. Such a procedure involves loss of considerable time and it also involves expert work which may not be convenient.

This and other defects inherent in quenched gaps are obviated in the improved construction devised by F. Lowenstein, in which the component gap elements, which are broadly of the tubular type, are so assembled and mounted that any spark gap element or unit is individually removable and replacable practically in an instant, without disturbing any other unit of the complete gap, and without the exercise of any special skill on the part of an operator. The number of spark gap elements in the series may be readily varied at will to adjust the total spark length in response to working requirements.

on the outer and inner shells respectively. This form of joint between the insulating rings and the shells or electrodes insures that the spark gap space is sealed substantially air tight, which is desirable. The seal is permanent even when the electrodes become heated and expand; for in the event of such expansion the electrodes press against the ring surfaces 18 and 19 which are similarly located as regards resistance offered to the radial thrust of the shell expansion, and the tightness of the joints therefore maintained.

Another advantage secured by this construction is that the clamping pressure of terminal rings 14 and collars 21 is exerted in a direction parallel to the gap surfaces, so that the width of the gap is independent of the clamping pressure. Where gap electrodes are held by clamping means exerting pressure transversely of the gap surfaces, the width of the gap and hence the performance of the sending system, varies with the degree of clamping pressure.

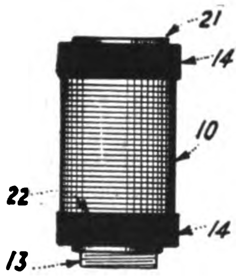
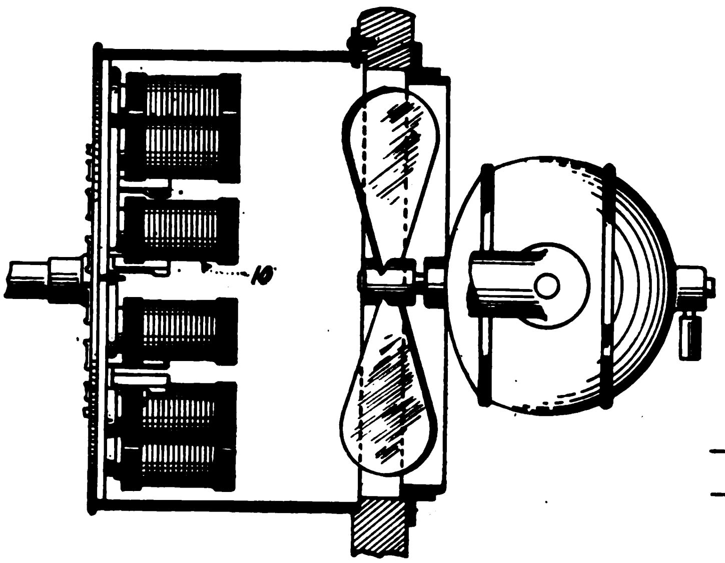


Figure 1



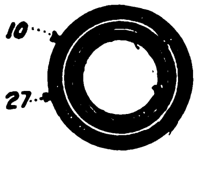


Figure 3

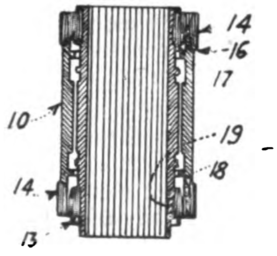


Figure 2

Figure 4

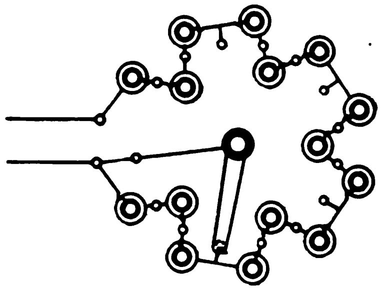


Figure 5

Various parts and the complete assembly of the quenched spark gap with cooling fan in place

Referring to figures 1, 2 and 3, the spark gap device comprises an outer cylindrical shell 10, within which is an inner shell 11 which in this instance projects unequal distances beyond the ends of the outer shell, the projecting portions being threaded as at 12 and 13. These shells or electrodes are made of copper and are spaced apart and insulated from each other by insulating rings 14, each of which is slotted or channeled along one side to accommodate an end of the outer shell or sleeve. Each insulating ring is thus divided into two connected parts, 16 and 17, whose parallel inner faces 18 and 19 engage the convex surfaces of the outer and inner shells, respectively. The parts 17 of the insulating rings extend between and space apart the shells to form the spark gap. The outer faces 20 may be slightly sloped or beveled as shown. The insulating rings may be locked in place by threaded collars 21 which are adapted to be turned down on threaded portions 12 and 13 of the inner shell into locking abutment with the rings. When the rings are in proper position they abut against shoulders 22 and 23

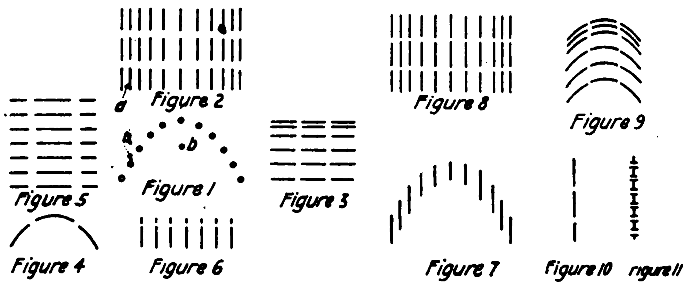
As shown, the central or intermediate portions 24 of the electrodes are formed in such a way that the annular spark gap spaced is narrower at this locality than toward the ends; and it is at this locality that the sparks actually pass between the electrodes. Annular circumferential ribs 10^a and 11^a formed on the electrodes 10 and 11, respectively, project into the wider portions of the gap space and are in staggered arrangement. These ribs act as baffles to prevent particles of metal from being "spattered" or otherwise transferred from the spark to the insulating surfaces at the ends of the gap, thus preventing deposit of metal on the surfaces and consequent destruction of their insulating properties.

The outer or convex surface 27 of the outer electrode shell and the inner or concave surface 28 of the inner shell are longitudinally grooved or fluted to provide a large radiation surface for rapidly dissipating the heat from the spark. In practice, when the spark gap is in operation, both these surfaces are cooled by a fan. Figure 4 shows the mounting of the gap and cooling fan. Figure 5 indicates the circuit for cutting in and out the gaps.

Marconi and Franklin's Directive Radio System

PARABOLIC reflectors to confine the radiated wave in a wireless system within a limited area have been devised by G. Marconi and C. S. Franklin. It is understood that these reflectors work extremely well and have been applied in a practical way for transmission at very short wave lengths.

The reflector is constructed of two or more sets of rods—which term includes strips and wires—arranged on a parabolic surface around the transmitting or receiving aerial as a focus, each rod being tuned to the aerial and the rods of the different sets being preferably in line with each other. By this means, the efficiency and effect of the reflector are very largely increased. For example, by making the reflector of three sets of rods arranged on a parabolic surface and having a focal distance of one-quarter wave length, the range may be increased from 400 per cent to 500 per cent as against 80 per cent obtained with the simple reflectors before known.



Detailed drawings of the newly devised parabolic reflectors

The construction in detail follows: On a parabolic surface surrounding a transmitter or receiver and in the correct direction having regard to the polarization of the transmitted waves, is arranged a number of long wires which are divided up into elements each in tune with the transmitter. The length of each element is preferably about half a wave length, but may be made either greater or less than this by inserting in it either a condenser or an inductance. The adjacent ends of these elements may be insulated from each other or joined by inductance coils or condensers, the controlling factor being correct tuning with the aerial. That means that each element when in its working position in the reflector is in tune with the aerial.

In practice, it has been found that some of the elements may be removed slightly from the true parabolic surface provided that those elements of the reflector which are nearer the focus than they would be if on the parabolic surface are tuned to a rather longer wave, and those elements which are farther, to a rather shorter wave. For very short waves, no earth connections are required or desirable, but for longer waves, it is an advantage to earth the aerial and the lower elements of the reflector.

Very good results can be obtained by arranging the elements on a cylindrical parabolic surface, but better results can be obtained by arranging them on a true paraboloid, particularly when using a reflector having a focal length equal to three-quarter wave length or more. In the drawings, figure 1 is a plan, figure 2 a rear view and figure 3 a side view of a reflector constructed in accordance with this invention.

Figures 7, 8 and 9 are plan view, rear view and side view respectively, of a third form of reflector.

Figures 10 and 11 are diagrammatic detail views each illustrating a single set of rods or wire reflector elements of which the reflectors may be built up.

The reflector illustrated in figures 1, 2 and 3 has three sets of parallel rods (a) arranged on a cylindrical parabolic surface with an aerial or antenna (b) at the focus. This arrangement is for concentrating vertically polarized waves in the horizontal direction.

In the arrangement shown in figures 4, 5 and 6, the individual reflector members are placed in parallel planes which are spaced apart vertically instead of being spaced horizontally as in figures 1, 2 and 3. The object of this arrangement is to concentrate horizontally polarized waves in the horizontal direction. In the arrangement of figures 7, 8 and 9, the reflector has three sets of parallel rods arranged on a true parabolic instead of a cylindrical parabola; this will concentrate both vertically and horizontally polarized waves in the horizontal direction.

These figures illustrate reflectors made with three sets of parallel rods or, stated otherwise, reflectors made up of a number of wires each divided into three elements, each element being in tune with the transmitted or received wave. As illustrated, each of these elements should be nearly half a wave length long; alternately each of these wires may be divided up into a larger number of elements connected together by condensers.

Figure 10 shows one wire divided into three elements each in tune with the desired wave. Figure 11 shows one wire divided into a number of shorter elements connected together by condensers. The capacity of each condenser must be such that if joined in circuit with the inductance of the wire joining it to the next condenser, it would form a circuit in tune with the desired wave.

Reducing the Dielectric Stress of Condensers

IT is a well known fact that high potential condensers, such as for example, the Leyden jar, are usually subject to break-down near the edges of the conducting armatures. The dielectric stress centers at these edges, although at other points between the plates, the stress may be nearly uniform. This concentration of pressure is evidenced by minute discharges or "brush" that pass from the coating to the dielectric. This playing of the brush over the surface of the dielectric causes local heating in the latter, due to its poor conductivity.

David T. May has devised a method whereby the localization of this stress is materially minimized. In figure 1 is shown a condenser of the Leyden jar type having inner and outer conducting plates. Extending from the edges of these conducting plates 8 and 8′ are two metallic caps, 9 and 9′ which are suitably attached to the dielectric but are electrically separated from the conducting plates by air gaps, 10, 10′, 11 and 11′, the latter pair being the

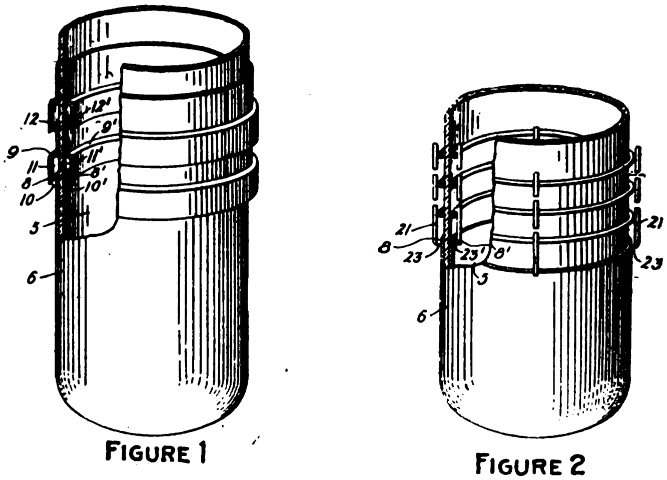


FIGURE 1

FIGURE 2

Condensers of the Leyden jar type

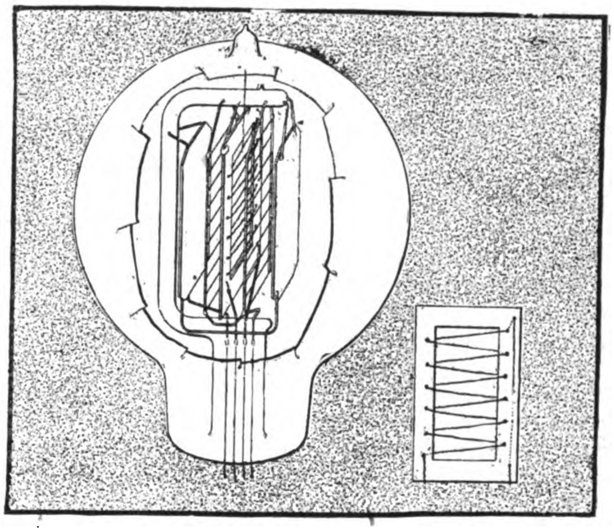
greater. When a condenser equipped with these caps is connected to a source of high potential, it is found that the brush no longer plays over the surface of the dielectric, but that sparks pass across the gaps 10 and 10′. In this way the stress at the edges of the plates 5 and 6 is considerably relieved and the interposition of the air gaps 10 and 10′ in the path of the current cuts it down to a point where the brush is not produced to an injurious extent at the edges 12 and 12′ of the caps. If it is desired, a plurality of caps may be employed, each one being separated from the preceding one by air gaps of suitable dimensions. It is preferable that the gaps 10 and 10′ should be smaller than the gaps 11 and 11′ because sparking across the shorter pair of gaps will be to those portions of the metallic caps from which the heat may be radiated away most readily without injuring the dielectric.

In figure 2 is shown a modification where metallic rings are sprung against the walls of the jar instead of the metallic caps. Each of these rings carry several wire pieces which form air gaps with the metallic conducting plates of the condenser. Harmless sparking will occur across the gaps 23, 23′ upon charging the condenser to a high potential and the injurious brush is thereby eliminated.

Warping of Filaments Prevented

Trouble has been experienced in the past in connection with the employment of filaments in vacuum tubes due to the fact that the cathode filament when heated becomes elongated and unless some means is adopted for overcoming it, a warping of the filament will occur. Inasmuch as the energy output of a thermionic device of this sort is dependent among other things, upon the distance between the cathode filament and the other electrode members, it follows that any warping of the filament toward or away from the grid member for example, will cause an alteration in the constants of the tube. It has in the past been proposed where filaments of loop form has been used, to remedy this defect by providing a spring support for the apex, thus placing the filament under a certain amount of tension and taking up an expansion of the loop in such a way as to keep the loop in its initial plane. Such tension on the filament has been found, however, to be undesirable in some instances, as tending to decrease the life of the filament.

Alexander McLean Nicolson has devised a method of maintaining the filament in its initial plane, which consists in entwining or threading the filament on a supporting member so that it will be held by the said support at several points distributed along its length. While this arrangement does not, of course, prevent the linear expansion of the filament, it minimizes the effect of such expansion in that it prevents the cumulative warping effect and confines the warping to several relatively short sections, the result being that the total effective lateral displacement of the filament due to warping is kept within reasonable bounds.

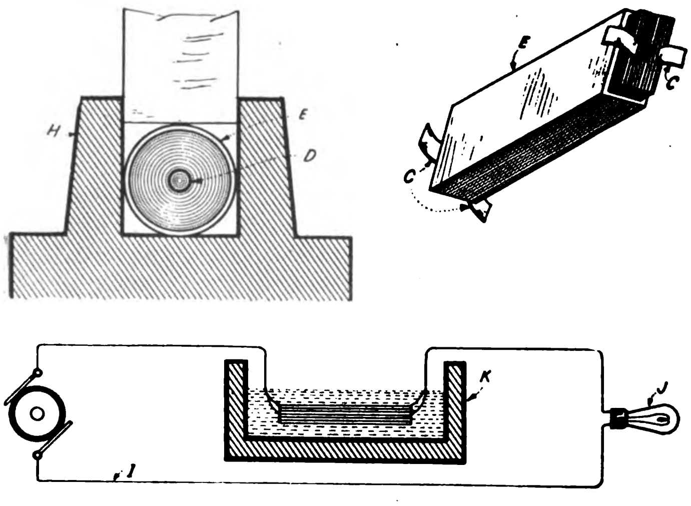


Nicolson construction of the filament on a supporting member

Eliminating Moisture from Paper Condensers

An improved method of overcoming difficulties encountered in the impregnation and the elimination of moisture from paper condensers has been devised by William C. Brinton. Ordinarily it is desirable to dry the paper used in paper condensers thoroughly in order that the moisture may be excluded, and this drying process oftentimes materially weakens the paper mechanically. After drying the paper and forming the condenser, it is necessary to impregnate the whole, quite some moisture being absorbed during the process of assembly due to handling.

In the method devised by Mr. Brinton, the difficulties are overcome by arranging the dielectric or conducting material (the paper preferably not having been preliminarily dried) winding the strip on a mandrel cylindrical in shape, withdrawing the mandrel, inserting the condenser into a tubular casing of drawn steel, and without intermittent treatment, subjecting the whole to pressure to convert the cylindrical condenser into a condenser of oblong shape and of considerably reduced volume. The condenser is then immersed in a body of dielectric impregnating liquid, such as wax or olive oil, preferably heated, and simultanteously an electric alternating current is passed through the condenser. This results in the conversion of the moisture into steam at a high pressure, the escape of the steam, and the replacement of the displaced water by impregnating dielectric liquid.



Showing construction of paper condensers to eliminate moisture

A Summer on the Great Lakes

The Third of a Series of Impressions of a Novice in Commercial Wireless Operating

By Julian K. Henney

III—Life on the Deep Blue Water

AFTER leaving Buffalo the Juniata followed the shore line of Lake Erie to Cleveland, arriving there the next morning. The clear sky, the blue water, and the fresh air made a fervent appeal to all of us, for we had been caged up on board the steamer all day long.

A few minutes after we left, the City of Detroit III slipped out of her berth on her way to Detroit, and at eight o'clock the Seeandbee started back to Cleveland. We had company on Lake Erie that night, but the wireless signals were indecipherable through the static. Shortly before arriving in Cleveland we tried to get into communication with WCX there, but atmospheric electricity was roaring in with all the sharpness and continuity of a tropical thunder shower. Then, and often during the summer, Watson and I thought of inventing a static preventer, but at each attempt we decided that it was slightly beyond the scope of our technical knowledge. Instead we devised methods of keeping the sparks from jumping into the receivers, and making blue flames all around the galena detector crystal. We hadn't fancied the carborundum supplied with the tuner which we had hooked from the Tionesta, so we had substituted galena from a small supply which I happened to have along. Needless to say, the crashes of "X'S" knocked the galena all over the place, and it was quite impossible to work Cleveland.

At six o'clock, we were startled by the ear-splitting scream of the Cleveland fog horn howling outside our porthole. That is some blast! I firmly believe that if all the unholy, unearthly and fiendishly disconcerting noises in the world were concentrated in one the Cleveland siren would have it beat. I much prefer to risk the perils of the fog unaided.

A few minutes later the black shape of the Western States crept past us in the early morning fog, making her way to the splendid new Ninth Street Pier; the Juniata poked her nose through the murkiness toward the deserted old coal docks where our passengers were scheduled to land. We tied up beside a coal barge and several camouflaged Shipping Board boats.

As we left, an hour and a half later, one of the camouflaged affairs appeared over the port bow with disconcerting suddenness. The sensation was an eerie one; in fact, often during the summer I watched those painted ships approach, never knowing whether the vessel was going sideways, forward—or straight up. In foggy weather it was almost impossible to see them at all.

In Buffalo we watched high-speed riveters put on the plates; in Cleveland we saw many of the new ships being loaded to their depth of eighteen feet; in Detroit we heard their radio equipments being tested, and in all of the northern ports we came across them at odd intervals. The continuous string of numbers which zigged off their wireless aerials by the hour was enough to drive a man crazy; they sent a message in plain United States, and I often wondered if the operators thought, dreamed, and ate numbers.

At noon of the second day we passed Colchester Light at the entrance to the Detroit river. The sun had chased away the last of the murky atmosphere, and the warmth felt good after the damp fog of the early morning.

Noon was one of the turning points of the day. It meant a change of watch for nearly everyone—and for half the crew it was a Godsend. In cold weather neither the decks, the pilot house, or the radio cabin were pleasant places, and a nice warm meal and bunk looked pretty good. To those of us who were compelled to climb out into rain or sleet, or the dampness of Lake Superior fog, the watch changing meant something. Midnight was also an important time of day, for at this hour the night tricks changed and the first mate starts his "six on" while the Second Officer and the Old Man slept. There was always a lunch in the mess rooms, warm coffee in the galley and, occasionally, some fruit.

That first noon hour on board the Juniata was indeed an important event. As usual, I was hungry. Sitting on a hard chair with the receivers over one's ears is not supposed to be a hunger provoking job, but Snell and I were always ready to eat when the time came. Answering the questions of all the women on board and half the men, sending an occasional message, constituted our principal duties. The queries were monotonously alike. "What is that wire for? I thought this was wireless," or, "That long rope hanging over the back end with the whirligig on it—is that your aerial?" Or a lady passenger would use up a half-dozen blanks writing a message to the kids, and then nearly faint when you suggested the rates—all of these occurrences somehow were hunger-provoking. And that first day was no exception.

Snell and I ate in the First Officer's Mess, along with the two mates, three engineers and the Purser's Assistant. The mess room was located about a dozen steps from the radio cabin and, with no occasion for delay, I was the first to enter the small room. As I sat down I felt that this was to be the supreme test. I awaited the appearance of the waiter with some apprehension and considerable anxiety. Snell and I had decided that we might as well inaugurate the season by asserting our authority from the start. We knew that it would be easier to have our own way from the first, than to wait until we got acquainted. The subjugation of the porters had taken place the night before; we had made them make up our bunks and bring us icewater. Now the campaign on the messroom waiter had to be accomplished without further delay. The performance started with a rush. There was no one in the room to see any possible failure and this rather emboldened me. As the waiter appeared from the galley, a clean towel over his arm, and a handful of shining implements in his hand, he queried: "Soup?"

"Well yes!" said I, with considerable rising emphasis on the latter part of "well." The effect was astonishing.

"Yes suh—yes suh—right away suh!" and Baltimore, the negro, rushed away to the galley with the greatest speed ever attained by any waiter. In a jiffy he was back with a bowl of steaming soup. He placed this in front of me with a most abject look and he kept offering crackers and celery, wiping the implements over and over again, and bowing and scraping so that I feared I would not get the soup down before I choked with suppressed mirth.

That soup was the hottest stuff I had ever tasted. Whether the heat was caused by the galley stove or by the militant seasoning of pepper was more than I was able to ascertain at once. By the time I had succeeded in swallowing several spoonfuls the Second Officer had come in. Bill was a huge fellow, fully six feet tall and wide in proportion; he towered over all the other members of the crew. He was the most feared man on board, and when there was any enforcing of the rules to be carried out, they let Bill do it. His brand of profanity was the choicest and his command of it was liberally attested to by the deckaroons, or common deckhands. When Bill came in and sat down he was puffing like an engine. I supposed he was peeved about something; but I soon discovered that Bill always puffed. Bill had the asthma. He also had a capacity for soup. Before he was ready to demonstrate this the rest of the officers had come in. Conversation began.

Bill pointed to the coffee, "I see they've been scraping the galley floor again," he observed.

The coffee did look a little muddy, and I thought I detected the odor of potato peelings and coal ashes.

But taste or looks did not bother Bill. He gulped the mixture at a swallow and called for more. Then he tackled the soup. Two spoonfuls were down before he looked up, reproachfully, at the Chief.

That officer returned a look of sympathy and understanding. "They tapped the well last night," he shot back.

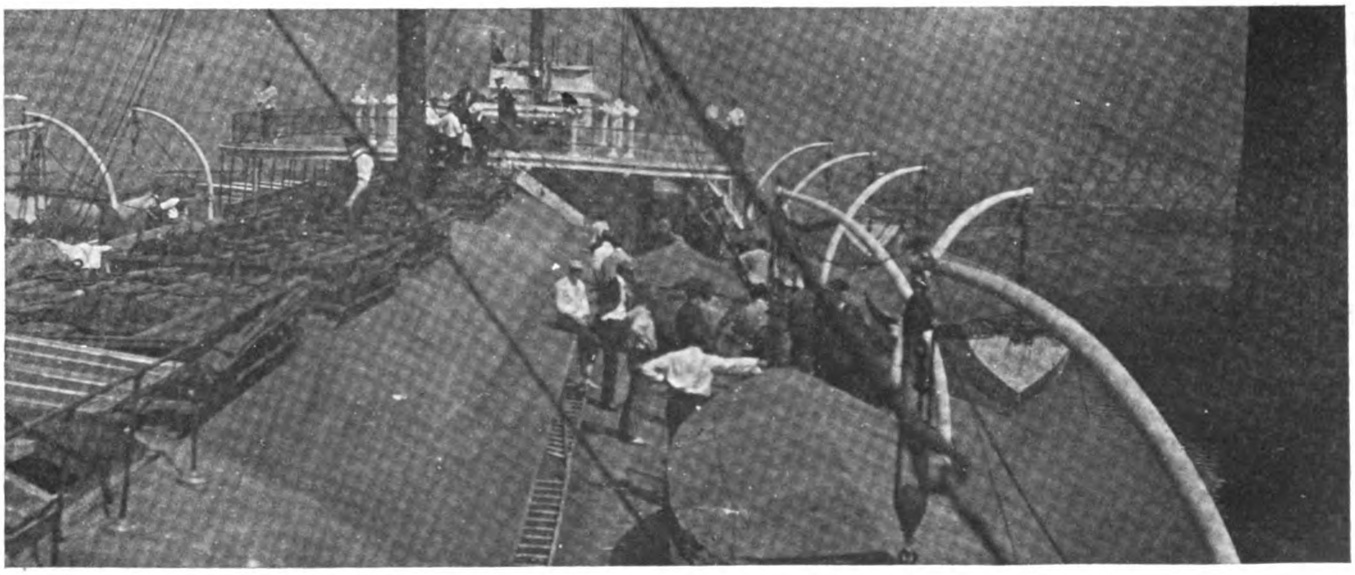
I had already noticed a rim of dark round objects at the edge of the soup. I had thought these pepper; now I wondered if they might be mud. I began to lose interest in the soup. But not Bill; he was gulping it down with all speed. Thoughts of the well—the bottom of the ship—and of the seepage or bilge water which it contained, did not disturb him. By the time Baltimore had brought me the remainder of my dinner, Bill was ready for more soup. It went with the same rapidity and lack of imagination.

Throughout the remainder of the meal the Chief found something wrong with everything, and never hesitated a second about springing any crude joke he happened to think of that might aid to describe the eats. His remarks were liberally punctuated by profane expletives. Finally, the First Officer put a stop to the rumpus.

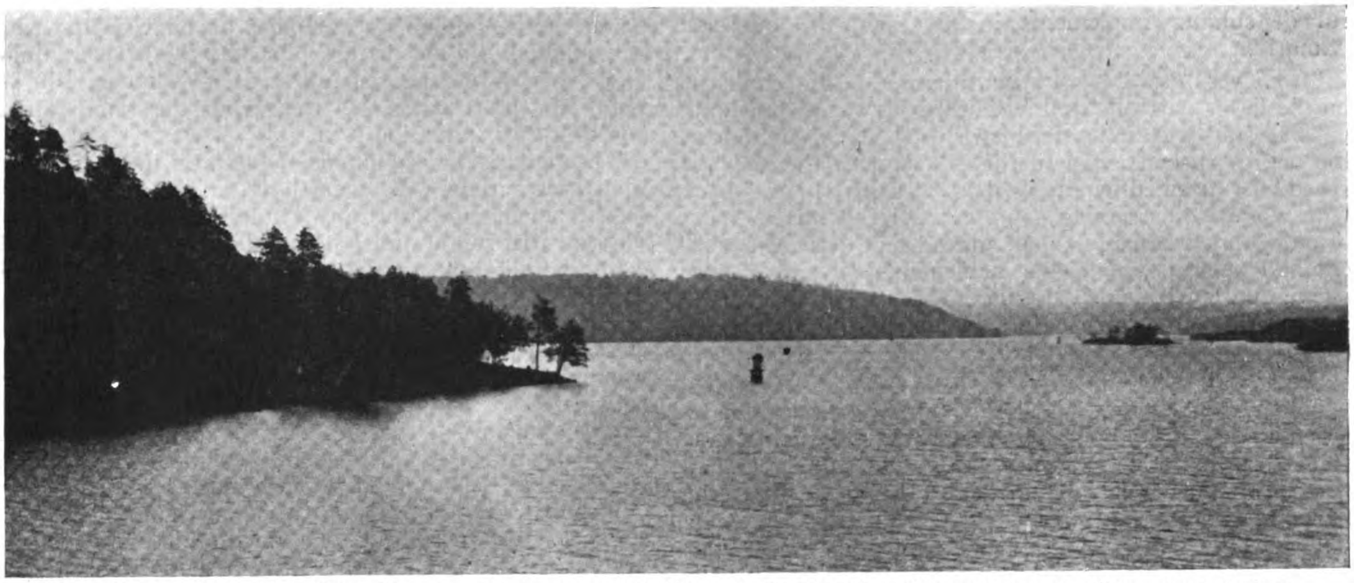
For several weeks the same performance was repeated at each noon and evening meal. The same kind of food was brought in and the same conversation took place between the Chief and Bill, in all of which the other officers and myself took little part. Later in the season the owner of the line happened to eat with us. After this we had the passenger bill of fare and each man was required to write out and sign what he wanted. This was an occasion for considerable mirth with Bill and the Chief. Neither wanted the other to know what he had ordered, but both were anxious to find out what the others had eaten. The new system livened things up a little and put us on a better basis as regards the rest of the crew.

When traffic was heavy the Purser ate with us. Occasionally, too, he ate with us after a night in the buffet, or when some woman passenger he didn't care for succeeded in getting a seat at the Captain's table. At such times the conversation was still more sordid. The Chief and Bill both knew that Mac's stomach was weak, and his digestion was easily upset so the conversation would start with the usual allusion to the galley floor, to horse meat and to bilge water, when Mac began to lose interest in the food the Chief would remark that the gravy tasted like tobacco. Immediately, the Second Engineer would note acquiesence and point to the galley slave toiling away in the corner of the second officers' mess, a big burly chap whose jaws worked constantly beneath cheeks eternally full of Honest Scrap. Purser Mac at this point of the game would look at Paul with such an appeal in his eyes that Paul would gravely reprimand the engineers and the rest of us who were enjoying the affair.

But to get back to my narrative. After dinner I was off duty and had six hours to use sleeping or loafing, as I chose. I found this a good opportunity to watch the beautiful scenery of the Detroit River. Cottages along the banks were flitting past in a never ending stream; many vessels passed us, and each saluted with the cus-



On the boat deck were the life rafts and bunks for the colored pantrymen; the upper deck was called the "flicker," but no one knew just why



When off duty I had good opportunities to watch the scenery; I alternated my sightseeing with wandering expeditions about the boat

tomary three long and one short blast, signifying that they were glad we were back on the Lakes again after lying idle for the winter. I alternated my sightseeing with wandering expeditions about the boat and soon became acquainted with the Juniata. She was a real vessel—much different from others I had been accustomed to sail on.

Forward on our deck—the salon deck—were the music room and library, both generously furnished with soft chairs and cozy corners where one might read or watch the scenic panorama. In the splendid weather we were having, however, most of the passengers were out on deck, lined up in the lee of the wind in steamer robes and chairs, or parading up and down the promenade deck. Aft of the music room, through a long corridor lined on both sides with parlors, were the social hall and stairs that led to the lower, or berth, deck. The social hall, decorated with well executed mural paintings was followed by the long dining room with its many tables and wide windows that let in all of the light.

The dining room was a beautiful place in the morning. The long rays of the sun came pouring in the port windows and were reflected from the polished floor and from the mirrors at the ends of the room. The mahogany of the chairs, their soft red plush bottoms, the white linen and shining service were something to remember, and I thought that morning that eight dollars a day was not too much to pay for these pleasant surroundings. At night the tables and chairs were unhooked from the floor and piled along the sides, clearing the center of the room for the dancers, called by the inviting music of the ship's orchestra. Fizzy drinks then appeared and the place took on the appearance of a metropolitan cabaret.

Aft of the dining room was the monstrous galley in which over five hundred meals were prepared each day. I did not explore this place at first, for it was teeming with blacks. Later I made it a haven when the weather was cold. All night long the fires were kept brightly burning, and a pot of coffee was always sizzling away on the back of the stove. Here I made the acquaintance of people I would have never seen otherwise, for they were coal passers and firemen, men who are not allowed the freedom of the upper decks. Every night these fellows came up from below to get a swig of hot coffee as the coal dust ran from their faces in streams. It was only occasionally that they could be persuaded to talk, for I was considered an officer and the men from the hold were timid about speaking to anyone so near the Old Man.

On the next deck—the boat deck—was little except the life rafts and boats, bunks for the colored pantry men, and a few choice parlors up forward. Aft were skylights over the galley, the engine room and the buffet, as well as many red ventilator funnels. The upper deck was called the "flicker" but no one knew just why.

Above the forward boat deck was still another deck, called the sun deck, where friends of the Captain and officers of the boat might sun themselves in nice weather. This deck communicated with the bridge and the pilot house, and it was usually by this route that I took messages and weather reports to the skipper. In the portion to which "our deliberate brethern" were relegated was a room devoted to social activities. Here were the fights, the banjo entertainments, and the crap games. A smooth table had been placed in the center of the room over which hung a lamp, casting a dim light over the players faces as they crowded about the dice, most of the light being directed to the table top where the lucky "bones" fell. At any time of the day or night when the men were not at work in the galley, the "come seben, come 'leben" could be heard as well as the arguments and blows that sometimes resulted from a throw of the lucky cubes.

At the extreme after part of the boat deck—back of the stack—was open space where the men often stretched out on the deck and slept in the sun. Many times I have stolen up the stairs quietly and found a half dozen blacks peacefully snoozing away, some with their backs against the hot ventilators, some on top the skylight where all the odors from the galley and engine room escaped, and some flat on the deck, half covered with cinders from the stack. They seemed to sleep with one eye open; one could never make any noise up there but what the whole bunch would jump to their feet in mortal fear that they had overslept and that the boss of them all, Tom Williams, had come after them.

Tom had been in the employ of the company at least as long as the Juniata had been in service, probably longer, and had come to that state of mind where he thought he owned the ship. His manner of storming and swearing at the blacks was enough to strike fear into anyone's heart, but his never ending tirade soon palled on me.

Friction between the upper men and those who lived and worked below decks was constant. I fully expected to see a full fledged battle on the flicker before the season was over, for the men of both parties were aching for a chance to get at the others. For this reason Tom kept his men up on top and away from the lower

(*Continued on page* 28)

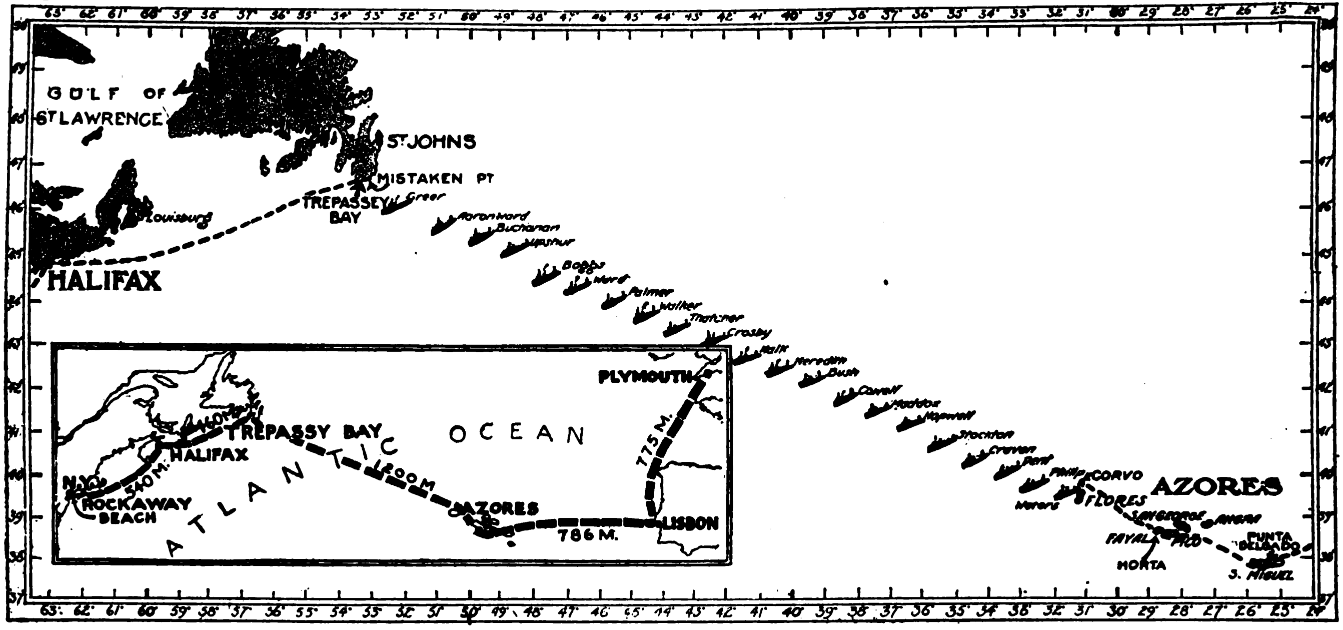
Across the Ocean on the NC-4

The Personal Narrative of the Wireless Operator on the Naval Seaplane Which First Spanned the Atlantic in an Historical Air Flight

By Ensign Herbert C. Rodd

PART II

(*Continued from August* WIRELESS AGE)



This map shows the location of the destroyers in the lane flung across the sea for the safety of the naval aircraft; the Author's wireless communications with these vessels and the shore stations is a feature of the article

SEVERAL minutes elapsed before I had any true realization that we were actually on our way overseas. Then the steady thrumming of the motors and a sight of the gradually fading shore line served to awaken in me a quiet sort of exultation in the fact that with good luck this enterprise might go down to posterity as an event in history.

More practical things, however, almost immediately engaged my attention. In the first transmission of wireless signals, using the skidfin antenna, I noted that the lead-out to this aerial leaked slightly, undoubtedly due to the fact that considerable water had been shipped in the take-off. These first communications were with the NC-1, and when we had been in the air for about three-quarters of an hour I let out the trailing wire antenna, from which all radio messages were thereafter sent and received until we neared the Azores on the following day.

The flag plane, the NC-3, soon after inquired for our position, asking if we were just astern of her; I sent a reply requesting that she turn on her running lights.

About a half hour later, while I was communicating with Cape Race station and with the other two planes, we passed over the second destroyer, and then twenty minutes later, I heard the wireless signals from the NC-3 requesting destroyer No. 3 to cease firing star shells, as they had sighted her.. Compass signals were then given and these were heard all the way to destroyer No. 10, more than 350 miles distant.

There were all sorts of interesting wireless communications registering in my head phones along about this time, one of which I recall came from the "Maumee" in the following fragmentary form:

"Maumee will not be able to move for three days comma that heavy. . . ."

Afterward I heard that she had broken down while plying back and forth through heavy seas to refuel the destroyers which were waiting for us. At the time the message was received she was in the vicinity of the Azores.

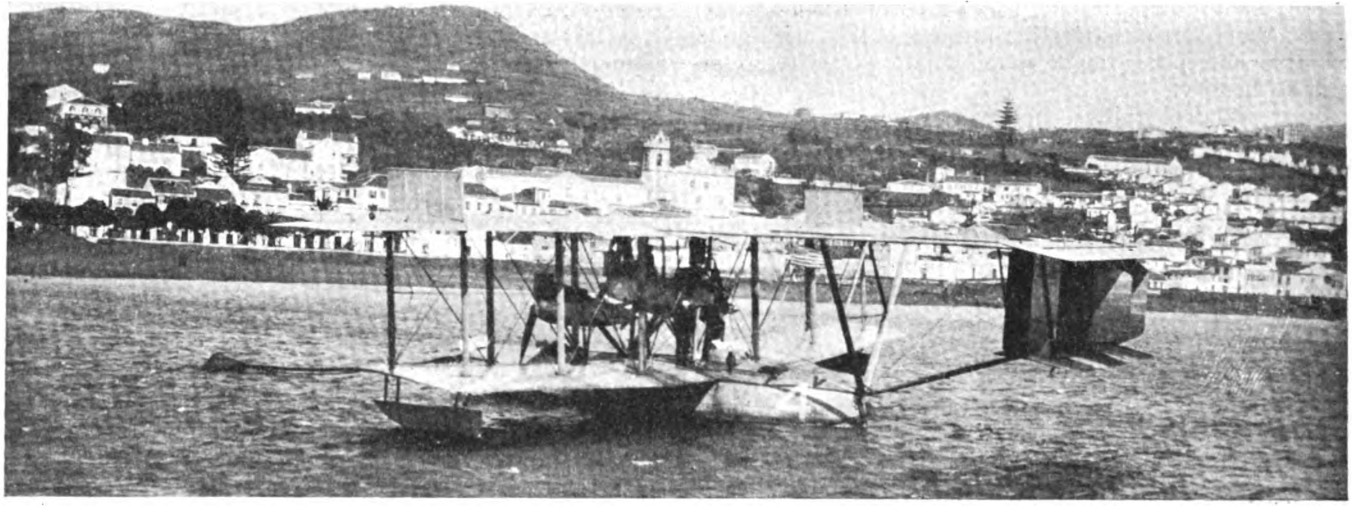
Within a half hour all three planes had passed station No. 4 and Cape Race reported by wireless, "signals good," which message was clearly received. Boston—then a thousand miles distant—came in, and I clearly heard her call the Acushnet.

My next communication to the destroyers informed them that we were about to inspect the motors on the NC-4, and proposed to use the Aldis lamp for this purpose. This lamp was intended for signaling, but as a matter of fact, it was an ideal light for examining the motor, although the idea had not struck us until this time. Incidentally, I might mention here, that perhaps the most inspiring sight through the entire trip was that of the four Liberty motors, each spitting six tongues of blue flames from either side. This roaring, flashing fire symbolized a wonderful mechanical achievement, for the flames bore direct testimony to the fact that the entire forty-eight cylinders were hitting perfectly.

In contrast to the flashing of the power explosions from the motors and the vicious blue shafts that belched from their sides, was the placid disc of the moon rising slowly from the surface of the sea. Cold ladders of light led out across the black waters below us, seeming to be harbingers of a guiding hand of Fate which would lead us safely to our island objective.

Any further philosophical thoughts which I might have entertained on the subject were interrupted when I happened on the tune of 1,200 meters and heard the station at Brest being called by one who signed himself NEC. I then copied the following message:

"S/S GEORGE WASHINGTON ne-1 Ck. 126. Confran. Position eight PM GMT May sixteenth. Lat. 47-05; Long. 23-00. Expect arrive Brest seven PM. GMT Sunday May eighteenth period. Please furnish five hundred tons fresh water comma eight hundred tons coal and stevedores upon arrival period carrying capacity three hundred fifty first class passengers six thousand three hundred thirty-five troops and one hundred forty stretcher cases subject to material reduction if president and party . . . Swedish minister to United States and wife on board. Please reserve Paris train accommodations . . . . (interference from UB2 calling CQ) . . . afternoon period Major General Squier and aide on board. Please reserve Paris train accommodations for . . . . eighty sacks navy mail."



The seaplane NC-4 at rest on the waters in the harbor of Horta, after completing the history-making flight across the Atlantic

A broadcast from destroyer No. 5, directly below us, interfered with the remainder of the message.

The George Washington was then 1,175 nautical miles or 1,325 statute miles away; I am certain that this distance was never before covered by wireless to an airplane in flight from a ship at sea.

Nothing of special consequence happened for about a half hour, then the station at Cape Race asked me to send a short story of the flight thus far, the distance which we had covered, and anything of special interest. A request was also appended for a report of the NC-3. I was not authorized to transmit messages of this charatcer so I merely replied that everything was going along O. K.

A few minutes after this message had been sent, the steamship Abercorn asked if she could help us in any way; and the next episode worthy of record was when destroyer No. 7 sent me compass signals which were audible 30 miles distant. I had regularly been reporting each time when we passed a destroyer, sending these messages clear to the Cape Race station at Newfoundland. Evidently they were being received, for the operator at Cape Race answered promptly each time.

We flew over destroyer No. 8 at 3:29 (Greenwich Meridian Time), and about twenty minutes later I sent out a 22 word message to my mother in Cleveland, Ohio, by wireless to Cape Race station. We were 425 miles away from the Newfoundland station at that time, and the operator at Cape Race marveled that I was able to hear his signals, when I told him that his signals were still good. He could not understand how it was possible to hear him through all the noise made by all four Liberty motors pegging away at full speed.

Lieutenant Harry Sadenwater, the operator on the NC-1, had kept in almost constant communication with me up to this point. We exchanged friendly messages between our work with the destroyers and felt highly elated at not being "called" by a shore station. It reminded us of the early days in wireless when chit-chat exchange between operators was tolerated to a great extent.

At 4:06 I asked destroyer No. 9 for a weather report and received his reply within four minutes. This illustrates the efficiency of our communication. I cannot say whether it was due to the electrical or mechanical design of our transmitter, or whether it should be credited to the excellent work of the operators on the destroyers; in any event, it seemed just as easy to call a destroyer 300 miles away and get a quick reply as it was to communicate with one which was directly under us as we passed by in our flight.

At 5:30 the naval men at Cape Race inquired as to the time when we had passed destroyer No. 10. I informed them that I had not picked up that vessel's broadcast, so did not know: the Cape Race operator responded with a lengthy message, asking that he be kept advised as to our position. He added the final comment: "Signals great."

A half-hour later I heard at one time six destroyers sending out their compass signals, these vessels were respectively numbers 12, 13, 14, 15, 16 and 17. No. 16, the Hopewell, more than 200 miles distant came in exceptionally loud.

Soon afterward we passed over destroyer No. 13, which information I imparted to Cape Race. Immediately afterward I heard, clear as a bell, a 14-word message sent to the Aroostook, stating that the signals from the plane were "great."

The NC-1 then inquired whether I had heard any wireless communications of the NC-3. I listened and found that the flag-plane was communicating with destroyer No. 13, and at the conclusion of these communications I heard her ask destroyer No. 16 for a weather report.

It was about 7 o'clock when I heard the station at Bar Harbor very faintly. The messages were being communicated to two of the naval vessels, probably off the coast of Maine, Bar Harbor being almost 1,100 miles away.

A half-hour later I sent the position of the NC-4 to Cape Race, but I did not hear this station answer. This was not surprising for the last communication I had sent had spanned a distance of 650 nautical miles.

I became a bit sleepy at this time and sought the open hatchway for a few breaths of fresh air. Chief Machinist Mate "Smoke" Rhodes had slept peacefully all night covered with life preservers, the only visible part of his anatomy being two feet set at a spread eagle angle. As the cobwebs were cleared from my brain by the rush of air, I began to speculate on the reasons why there was no noticeable change in temperature, for I had fully expected it to become warm as we approahced the Azores. Then I recalled how at Rockaway I had counted on writing some letters during the long flight. I had often done this before, and in the rush of things preceding our departure I had made a mental reservation that I would catch up with several weeks correspondence; but nothing had been done on the flight; I never had a spare minute, it seemed.

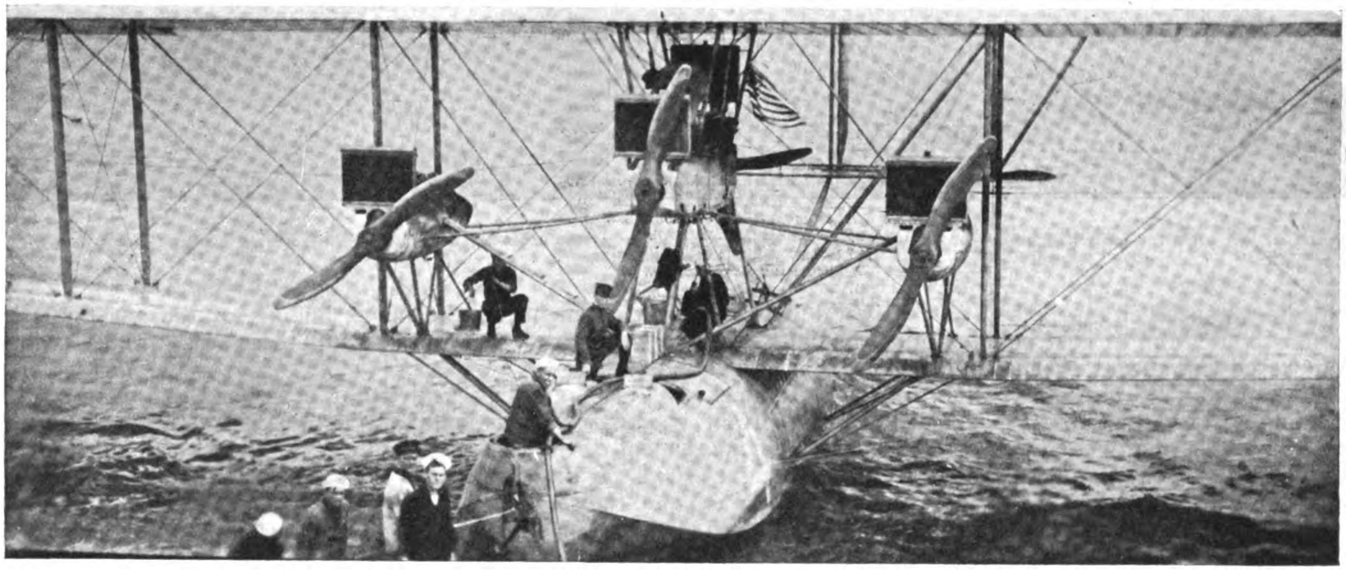
When I returned to the instruments I picked up Lieutenant Sadenwater of the NC-3 and remarked that the thought of sleep had never occurred to me. He replied that perhaps, too, I had not thought of food, adding that he had a sandwich in his hand at the moment. He was right; I had given no thought to the supplies we had taken aboard at Trepassey. "Smoke" was awake by this time and I scribbled off a note asking him to go back and get a sandwich. When it came, I seemed to have no taste for anything but the buttered bread. I got away with this, but passed up the coffee, for the Thermos bottle in which it was contained, was faulty and the contents were cold.

We crossed the steamer lane soon afterward and there was considerable interference on the 600 meter wave length. I heard the NC-3 calling destroyer No. 17 and by the strength of his signals I figured that the craft was a good distance ahead; the NC-1 then came in loud, and I noted that this vessel was just one station behind.

The hour between 8 and 9 was a busy one. The steamship Imperoyal wished us good luck and stated that she was bound from New York to Spain with gasoline. A few minutes later I heard two vessels calling Cape Race; one sent a message and the other reported to some station that he had met two planes and had a good time communicating with them. I found it was possible to hear two destroyers at once with the amplifier entirely disconnected from the receiver, antenna and counterpoise. A remarkable record was made, too, in this hour, when the NC-1 asked the destroyer No. 16 for a weather report and received a reply in one minute.

Destroyer No. 17 notified me at 9.31 that the NC-3 had just called with a rush message but that the operator could barely hear it. This was the last heard of the NC-3. Fifteen minutes later we struck a heavy fog and from then on I adjusted to the 1,500 meter wave length so as to get all the compass bearings possible.

The hour from 10 to 11 brought some anxiety. At 10:30 I established communication with destroyer 19 and asked if he heard our motors, explaining that we were flying between the fog and the clouds. The reply came back that the destroyer had not sighted us, but that the operator on board thought we were off her port bow. I was just about to ask for compass signals when the navigator came aft and requested me to inquire about the fog conditions close to the water in the vicinity of destroyers 19 and 20. I received an immediate reply from 19, stating that the fog was very thick near the water; destroyer 20 then wirelessed the information to me that it was misty in her vicinity. The operator on this vessel asked whether we were flying high or low and I told him: "high, but we want to come down if it is clear at the surface."



The epochal flight had just ended when this photograph was taken, but to the Author this seemed relatively unimportant; he was far more concerned with securing the soothing solace of a cigarette

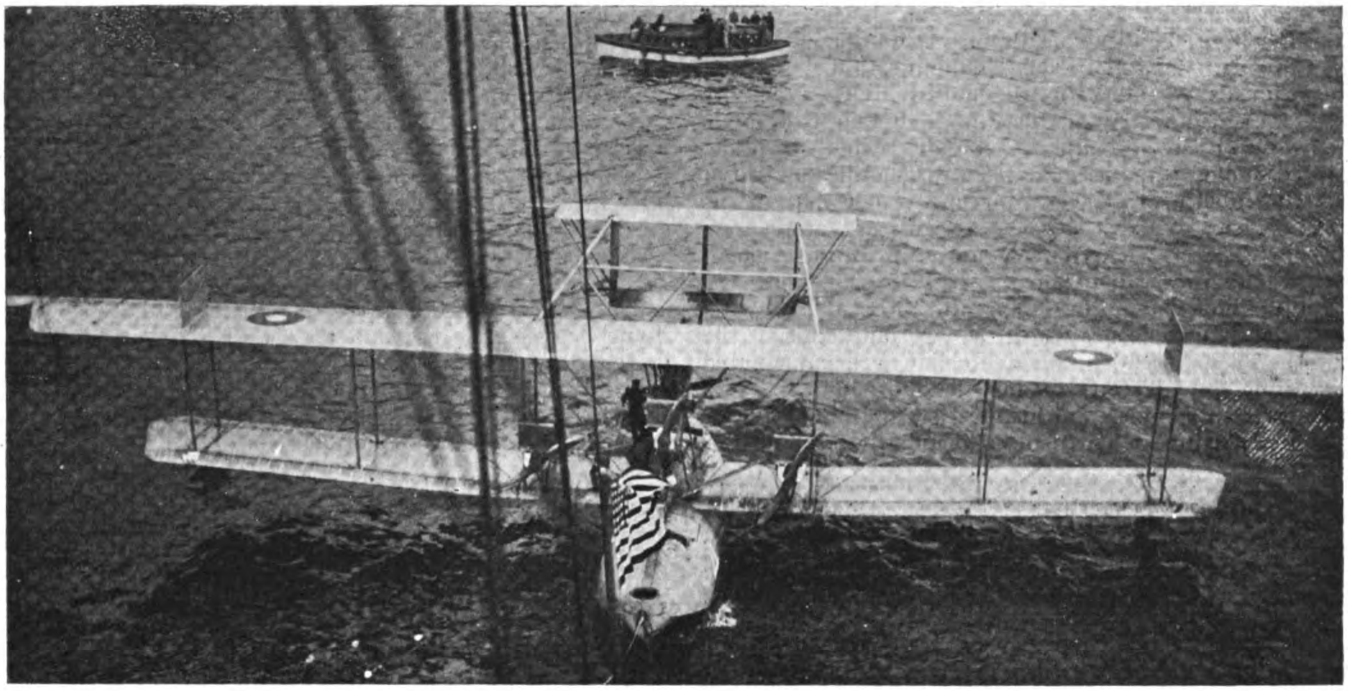
At 11:13 destroyer No. 21 replied to my inquiry that the visibility at the surface was 10 miles and that the wind was blowing at the rate of 20 miles an hour.

Then, at 11:30, we sighted Flores—the most welcome sight that had ever greeted our anxious eyes.

We came down near the surface so I reeled in the trailing wire aerial and in subsequent communications used the skid-fin antenna. We were concerned about the NC-1 and the NC-3. I inquired of destroyer No. 23 whether the other planes had been heard. A reply stated that the NC-1 had passed two hours earlier and that a message had been intercepted stating that the NC-3 was off her course between destroyers 17 and 18. The information immediately followed that the NC-3 had just been heard, asking for bearings.

Forty minutes later we picked up land again, sighting rocks that were so close on our bow that the craft had to be raised instantly to avoid striking them. As we came down to the surface of the water, I worked with the Cruiser Columbia lying in the Bay of Horta.

Hardly had we brought the craft to a standstill when the captain's gig of this vessel came to meet us. The doctor on the Columbia evidently expected to find us all



The NC-4, just after the craft had been brought to a standstill on the conclusion of the cross-ocean flight to the Azores, a dramatic moment in the annals of aviation

in, for he was perched on the bow and loaded down with Thermos bottles full of beef bouillon and stimulants.

We were by no means exhausted, but the hot beverages looked good and no member of the crew refused them. Welcome as this attention was, however, the important thing to me was the opportunity at last to get a smoke. All night I had been tantalized by the fragrance of cigarette smoke wafted through the passageways of the plane. Commander Read had permitted smoking in the forward compartments of the plane, but aft of the gas tanks it was considered dangerous and there was nothing doing for me.

As I looked back at it now it seemed relatively unimportant that our landing at Horta meant the accomplishment of the first successful air flight across the ocean. I was far more concerned with the relaxation of restrictions and the soothing solace of a cigarette.

(*To be Continued.*)

A Summer on the Great Lakes

(*Continued from page* 24)

decks but there was little to prevent the firemen from coming up on top after the blacks. If ever a time comes when the two gangs of men decide to have it out—and such a time must surely come—there won't be any Juniata left. Of the total crew of a hundred and thirty, at least sixty were black, so one could expect a pretty good battle—and an even one too.

Below us was the berth deck, so called because most of the staterooms were here. Here, too, was the barbershop, more bunks for the engineers, barber, bellhops and some of the colored fellows who could not be accommodated on top; also the "fantail." This was the extreme after end of the ship where the huge coils of rope—the breast and stern lines—a steam capstan for making fast the line, and a shower bath for the crew were conveniently located. The shower consisted of a hose placed in the center of the space and hooked to the ceiling or deck above, so that it could be moved about by the recipient of the water. As the fantail was decidedly open to the public, shower baths were prohibited during the day time and when near port. Only when the ship was on the "high seas" could the affair be used; even then I doubt if it was ever used, for the officers had a shower of their own, less public by far; and the crew—well I am not sure that they thought an occasional shower necessary.

One man always went swimming in the third engineers trousers when we docked at Mackinac, but the rest of the crew must have been cleansed by liquid fire and suggestion rather than by the use of water. So the fantail was used not for a bathhouse, but for the customary shipboard poker and crap games. Here the members of the crew made and lost their money, several hundred dollars often changing hands in a single day. The rail and the capstans were filled with shouting followers of the game who tossed their quarters and halves into the ring with the utmost abandon. Only when the steamer docked did the dice game stop, and then only because the players were afraid of police, or because they needed their money for refreshments.

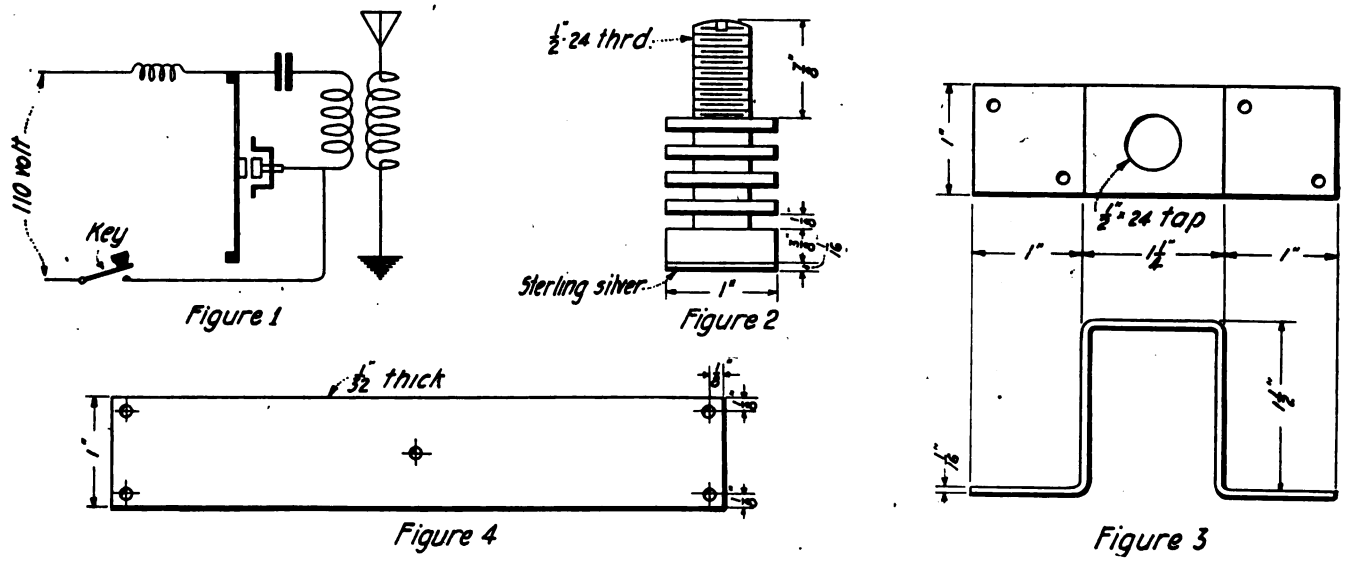
Still another deck was below the berth deck, this one being used for most of the freight which could not be stored in the hold. Here was the passenger gangway with the offices of the Purser and Steward on opposite sides of the stairs leading to the upper decks and the social hall. The engine room was also on this deck, although the engines proper were still further down, and there usually was a pile of coal which was carried on deck and not placed in the bunkers. This was used in cases of emergency when the coal below was gone or on fire and could not be used. On this deck was stored the copper and zinc ingots which usually comprised part of our freight. The flour and dry goods cases and such stuff were swung into the hold by steam winches which kept up their terrible squeak for a day and a night while we were in Buffalo and Duluth.

EXPERIMENTERS' WORLD

Views of readers on subjects and specific problems they would like to have discussed in this department will be appreciated by the Editor

A Simple Buzzer Transmitter for Amateur Use

THE buzzer type transmitting set will no doubt find wide application in the experimental field due to the ease of construction and low cost. The instructions here given, were purposely made very general in order to encourage the experimenter to follow his own initiative in varying certain dimensions. Since the cost of these experiments will be very slight and will require little else than time and patience, the amateur will no doubt welcome these general instructions rather than the more explicit instructions given in the usual constructional article.



Constructional details and dimensions of the buzzer transmitting set

Buzzer transmitters have been made in a variety of sizes for various uses, powers and voltages. In a subsequent article photographs and descriptions of the standard transmitters furnished to the Navy and Signal Corps will be given. The purpose of this article is to describe a 75 watt outfit suitable for operation on 110 volts D.C. Figure 1 shows the elementary wiring diagram. The iron core choke which operates the buzzer contacts, for use on 110 volts should have a core of No. 22 soft Norway iron core wire about 1" in diameter and about 4½" long. The winding space is about 4" long and ¾" deep making the diameter of coil over the winding about 2½". The space is wound full of No. 22 B&S D.C.C. magnet wire.

The vibrating spring of the buzzer, figure 4, is made of 1/32" spring steel or cold rolled steel, preferably the former, 1" wide and 5½" long. On the rear of the spring is fastened an armature of soft iron 1" in diameter and ¼" thick. On the front of the spring is mounted a piece of copper of the same size as the armature to which is soldered a piece of 1/16" sterling silver which acts as the vibrating contact. The stationary contact is formed as shown in figure 2, and is also fitted with a piece of sterling silver 1/16" thick and 1" in diameter. Figure 3 shows a simple way of supporting the stationary contact, figure 2. It is made of 1/16" sheet brass 1" wide and is bent as shown.

The condenser is easily constructed of mica or glass plates. The dielectric must only withstand a break-down test of about 500 volts. For 200 meters, the capacity should be about 0.013 mfd. Any standard text book will show the experimenter how to calculate the dimensions of this condenser. It can be purchased quite cheaply because the voltage is very low.

On account of the low voltage generated in this set, practically any kind of an oscillation transformer can be used. A suitabe transformer has about 15 turns of No. 12 B&S bare copper wire, wound on a form about 11 or 12 inches in diameter. One or two turns placed on the inside act as the primary. The primary need not be moved with respect to the secondary as the oscillations in the primary are quenched so rapidly as to give almost *impact excitation.* For all wave lengths between, say 150 meters and 300 meters, it is necessary only to add more or less turns in the secondary while the primary and coupling remain constant.

The contacts are the most expensive part of the outfit; in order to get a good job done in sweating the silver to the copper, it is advisable to have the work carried out by a jeweler. The contacts need to be large for the reason that currents in the neighborhood of 40 amperes flow in the oscillating circuit so it is necessary that the contacts be faced off absolutely parallel in order not to pit the silver, but to make use of the entire contact surface.

The theory of operation is as follows: Referring to figure 1, when the key is depressed current flows through the iron core inductance, thence through the contacts which are normally closed and back to the line; this energizes the iron core choke and it attracts the iron armature and abruptly opens the circuit at the contacts. The energy stored in the choke—equal to $\frac{1}{2} LI^2$—now flows through the closed oscillatory circuit which bridges the open gap and charges the condenser. The energy stored in the condenser—$\frac{1}{2} CE^2 = \frac{1}{2} LI^2$—discharges across the now closing gap and produces damped oscillations which are quickly damped out in the primary circuit. The secondary circuit then oscillates at its own natural period. The action of course, is repeated indefinitely as long as the key is depressed.

As mentioned before, the primary oscillations are quenched out so rapidly as to give substantial impact excitation. Let us now consider the reason for this rapid quenching. There are many factors which contribute to quenching. They are enumerated as follows:

1. The cooling effects of the massive metal plates.

2. The magnetic blow-out due to the magnet coil mounted behind the contacts.

The mechanical quenching due to the contacts actually closing or opening the circuit.

4. The re-transference of energy from the secondary back to the primary due to the close coupling.

The set is adjusted as follows: Depress the key and screw up on the stationary contact until a smooth note is obtained and an ammeter in the primary source of power reads about 0.75 amperes. Next adjust the number of turns in the secondary circuit until the wave length is the correct value as indicated on a wave meter. On a small antenna a radiation of about 1 ampere may be expected and a distance of about 20 miles can easily be covered. This outfit will produce a very smooth but low note and is practically noiseless in operation. If a commutator form of "chopper" is inserted in the ground circuit any note desired can be produced at the will of the operator by simply varying the speed of the motor driving the chopper.

Some items to experiment with are the variation of air gap between the choke coil and vibrator; making the choke coil core movable and noting its effect on the note without the chopper; and last but not least the re-design of the coil and the adaptation of the set to alternating currents.

M. W. Sterns—*New York.*

Suggestion for Prize Contest NOVEMBER Wireless Age

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We will pay the usual prizes of $10, $5 and $3, in addition to our regular space rates, to the three contributors who send us the best manuscripts on the following subject:

In your opinion, what is the best rotary spark gap design, both mechanically and electrically, for the amateur?

List of Long Wave Stations

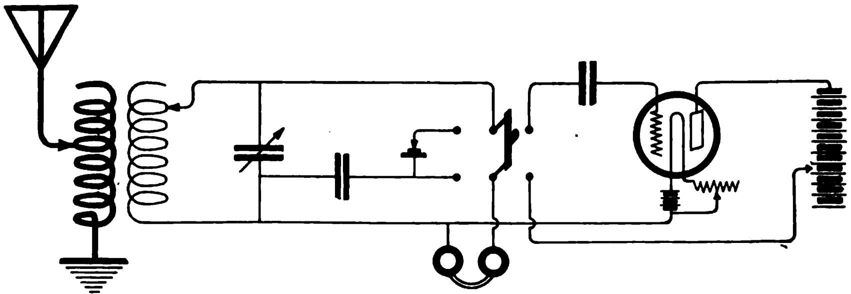
Call	Location	Type	Wave-length
BUC	Taranto	Arc	3,500
			4,166
BWP	Punta Delgada, Azores	Arc	2,000
BWW	Gibraltar	Arc.	2,750
		Spark	4,600
BUCQ	Jassy, Roumania	Spark	6,000
BXY	Hong Kong, China	Arc	5,000
BYC	Horsea, England	Arc	4,500
BZI	Jacobs, Durkin, S. Africa	Arc	2,700
BZK	Bathurst, Sierra Leone,	Arc	3,600
	W. Africa	Spark	2,000
BZL	Demarara, Br. Guiana	Arc	4,200
		Spark	1,279
BZM	Mt. Pearl, N. F.	Arc	4,200
		Spark	1,525
BZO	Ascension Islands	Spark	4,600
BZQ	Christiana, Jamaica	Arc	4,200
		Spark	1,280
BZR	Bermuda	Arc	4,200
		Spark	1,525
BZV	Port Nolloth, Hong Kong	Arc	2,000
		Spark	3,263
BYZ	Renella, Malta, Med. Sea	Arc	4,600
		Spark	4,600
FFH	Bezierte, Tunis, N. Africa	Arc	6,000
FKQ	Martinique	Spark	1,000
FL	Eiffel Tower	Arc	10,000
GB	Glace Bay, N. F.	Spark	7,500
ICI	Coltano, Italy	Spark	6,500
IDO	Rome, Italy	Arc	11,000
LCM	Stavanger, Norway	Timed	12,000
		Spark	9,500
LP	Berlin, Germany	Spark	5,500
MFT	Clifden, Ireland	Spark	6,000
MUU	Carnarvon, Wales	Arc	14,000
MPD	Poldhu, Ireland	Spark	2,800
NAA	Arlington, Va.	Arc	6,000
		Spark	2,500
NAD	Boston, Mass.	Arc	5,000
NAM	Norfolk, Va.	Arc	5,250
NAO	Charleston, S. C.	Arc	4,750
NAR	Key West, Fla.	Arc	6,500
NAU	San Juan, P. R.	Arc	5,000
NAW	Guantanamo Bay, Cuba	Arc	4,500
NAY	Pt. Isabell, Texas	Arc	8,500
NBA	Darien, C. Z.	Arc	7,000
NDD	Sayville, L. I., N. Y.	Generator	9,800
			11,600
NFF	New Brunswick, N. J.	Generator	13,600
NPG	San Francisco, Cal.	Arc	8,600
			4,800
NPL	San Diego, Cal.	Arc	13,300
			9,800
NPM	Pearl Harbor, Hawaii	Arc	11,000
NPN	Guam, M. I.	Arc	5,000
NPO	Cavite, P. I.	Arc	12,000
NPU	Tutuila, Samoa	Arc	6,000
			3,000
NSS	Annapolis, Md.	Arc	16,900
NWW	Tuckerton, N. J.	Arc	9,200
OUI	Eilvese, Germany	Generator	15,000
PMX	Java, Dutch, E. I.	Arc	6,100
POZ	Nauen, Germany	Generator	12,600
SQC	Cairo, Egypt	Arc	5,800
SUC	Suda	Arc	5,860
			3,870
UA	Nantes, France	Arc	11,000
			9,000
VCU	Barrington	Spark	1,525
			3,500
VJZ	Rabaul (Pacific)	Spark	2,900
VKT	Nauru (Pacific)	Spark	2,200
VMG	Apia, Samoa	Spark	2,000
VPW	Singapore, Malay Peninsula	Arc	3,400
WSO	Marion, Mass.	Timed	2,000
		Spark	2,000
XDA	Mexico City, Mexico	Spark	4,000
YN	Lyons, France	Arc	15,500
	Aden	Arc	4,441
	Amethyst	Arc	4,200
	Corfu	Arc	6,000
	Milo	Arc	4,160
	Toulon	Arc	6,000

Change-Over Switch for Use of Audion or Crystal Detector

THE accompanying circuit shows a very simple and efficient method of using either a crystal or a valve with the receiving tuner. One movement of a switch is all that is necessary to change the tuner and telephones from one detector to the other. The switch may be either the regulation double pole, double throw type, or of the pole changing pattern, which has two levers connected by an insulating strap carrying the handle. Of the two contacts at the rear of this switch, one is connected to each lever, and each lever slides over two of the four front contacts. This latter type of switch may be easily constructed of six ordinary switch-points and the scrap to be found in any radio man's laboratory. It may be placed directly on the front of the receiving cabinet in a space a little over an inch square.

This circuit was designed and thoroughly tested out by Mr. George A. Wolf, one of the radio operators at New York Police Headquarters, and so far as known is the simplest and most efficient method of accomplishing the change-over from the valve to the crystal detector. It will be noted from the diagram that placing the switch on the left contacts gives the standard crystal detector circuit; when placed on the right contacts, the standard audion circuit results, and on either position, very few "hanging-on" pieces of apparatus appear.

In many instances an operator desires to save valve material for delicate work, and to use a crystal detector for ordinary receiving. A panel set equipped with both types of detectors and this circuit makes an ideal receiving outfit, and may be as readily constructed as a single detector type. The use of the pole-changing type of switch is advised, because of its neat appearance and the small space required.


Circuit using either a crystal or valve with the receiving tuner

For receiving undamped waves a wire may be led from the aerial lead, direct to the plate, as in the circuit developed by Mr. Chambers a few years ago. When this is connected, undamped waves up to the wave length of the tuner may be received. this lead may be inside the case of the receiving set, and arranged to be connected, at will, to the plate circuit by a single small switch which would be as near to the plate lead as possible.

Amplifying valves may be connected to this valve in the usual manner; and other detectors, or a potentiometer may be used on the crystal side. While it is possible that such additions may cause a slight change in the dead-end effect, it is hardly probable that this would be detrimental to the efficient operation of the circuit.

Chas. E. Pearce—*New York.*

Variable Tuning Inductance

THE variometer, besides being cheaply and easily constructed is a very useful instrument for the amateur wireless station, as it allows a gradual variation of the wave length in receiving circuits. This is important since close tuning is a necessity for efficient work in long distance reception. The energy losses due to the resistance of the winding of a large variometer are appreciable when used at small values of inductance, but it is a good instrument to use in series with a loading coil, for tuning between the taps of the coil.

The accompanying drawing shows a method of incorporating the variometer and the loading coil in one instrument making a compact and easily operated tuning inductance, and giving a gradual variation of inductance from practically zero up to any value desired. The coil in figure 1 consists of No. 28 S.S.C. wire wound on a 5" tube. It is arranged in 3" sections as shown, a tap being taken at each section and connected to a multi-point switch. Since this wire winds 60 turns per inch, there will be 180 turns per section. The two bottom sections are ¾" long, each consisting of 45 turns. The rotor coil also has two ¾" sections of 45 turns each. Leads are brought from this coil with extra flexible cord, and connected in series with the outside winding. One of these leads connects to one of the binding posts. The other binding post is connected to the shaft of the multi-point switch. The tube on which the rotor coil is wound is 4¼" in diameter by 2" long which allows enough clearance if the thickness of the outside tube is not over ⅛". The drawing shows clearly the method of mounting the rotor coil. Since every experimenter will use the material at hand no minor details are covered.

The inductance is varied by means of the multi-point switch and by rotating the inside coil. When this coil is tuned so its magnetic field opposes the field of the outside coil, the inductance is minimum; when tuned so its magnetic field assists the field of the outside coil, the inductance is maximum.

The length of the outside tube and the number of 3" sections wound on it depends upon the wave length of the signals it is desired to receive.

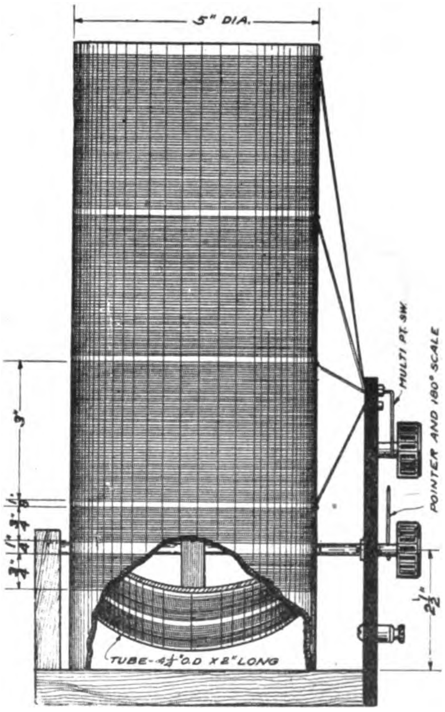


Figure 1—The variometer and loading coil combined in one instrument to form an easily operated tuning inductance

If this coil is used with the regenerative vacuum valve circuits for the reception of undamped waves, the control handles should be at least 12" from the coil, otherwise the presence of the operator's hand near the coil affects the signals. When the inductance is adjusted to the signals, removal of the hand from the control handles will eliminate the signals if the control handles are less than 12" from the coil. Any movement near the instrument will change the tone of the signals. This is due of course, to the capacity of the operator's hand, which changes the natural frequency of the circuit.

C. J. Fitch—*Massachusetts.*

First Prize—Long Wave Receiver

By C. R. Leutz

Figure 1 shows the layout of a receiver which has a range from about 2,000 to 20,000 meters when used with the average amateur antenna. I claim for this receiver that it is particularly selective and at the same time simple in construction. Selectivity on long wave lengths, now that there are so many high power stations working on this side of the Atlantic, is particularly desirable if one wishes to receive the trans-Atlantic and trans-Pacific stations at all times.

Figure 2 is a theoretical wiring diagram and together with figure 1, will give the reader a very good idea of what is required in the way of apparatus. This apparatus in addition to the coupler cabinet, consists of a primary condenser, a variable condenser, a bridging condenser, and the audion panel. These three variable condensers should have approximately a maximum capacity of .001 mf. Larger condensers, of course, may be used as well as smaller, but the wavelength range will be increased or decreased accordingly.

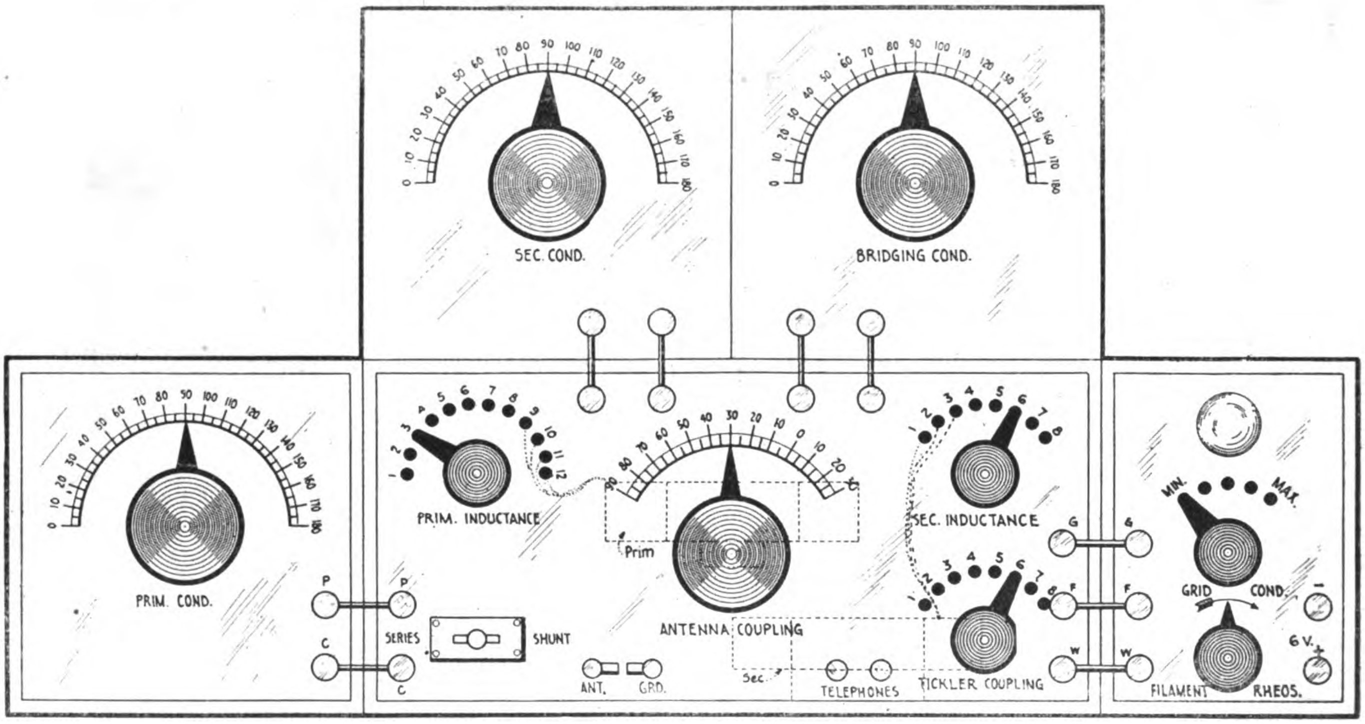


Figure 1—Main panel of the long wave receiving set showing position of instruments

It has been considered unnecessary to show the construction of the switches, condensers, audion panel, etc., inasmuch as these subjects have been covered in previous articles in The Wireless Age and are subjects more or less familiar to all amateurs.

From articles which appear in print from time to time and from questions which various amateurs have asked, the conclusion is reached that amateurs generally have not only failed to find a really good method for affecting reception on the long waves, but that a great many of them apparently do not thoroughly understand the requirements for this sort of work. There is an impression among amateurs, and this is quite general, that better signals are obtained when direct coupling between antenna and closed circuits is used. This opinion is persisted in no doubt due to the fact that louder signals may be obtained from the high power stations which are near by. Direct coupling gives rise to losses which are serious when incoming signals are weak.

Although various articles which have been printed from time to time in The Wireless Age, and all recent text books giving data on vacuum tubes and vacuum tube circuits, have very clearly pointed out the methods of securing regenerative and oscillatory action in a vacuum tube receiver, there still seems to be considerable confusion in the mind of the amateur as to how this may be accomplished. Some seem to be satisfied with the placement of the telephone receivers in common to grid and plate circuits, the two circuits being coupled by virtue of the capacity in the telephone cord and in the magnet windings. Others resort to capacitive coupling between the plate of the detector tube and the antenna circuit and thence to the secondary or grid circuit. Still others connect the plate of the detector directly to the antenna circuit and capacitively couple the plate circuit in this way to the grid circuit. Still many others use odd and various combinations of the above three methods with what pretends perhaps to be a proper and logical method. It is apparent that under circumstances such as these, the control of the coupling between wing and grid circuits is usually uncertain and in some cases no real control at all is available. Perhaps it might be pointed out that in order to obtain oscillations from a three element vacuum tube, it is necessary to couple the plate circuit with the grid circuit. This may be done inductively or capacitively, or the plate circuit may be tuned to the same frequency as the grid circuit, in which case that small amount of coupling provided by the connections to the filament and the filament itself which are common to both plate and grid circuits give sufficient coupling to set up oscillations when the two circuits are in resonance. This, of course, is inductive or conductive coupling. It is quite apparent that any combination of inductive and capacitive coupling with wing tuning in addition, will provide oscillations, but for all practical purposes, the simplest method which will give a generation of oscillations and at the same time afford perfect control over a wide range of wavelengths, is the most desirable method.

Any claim to novelty which the receiver here shown may possess lies

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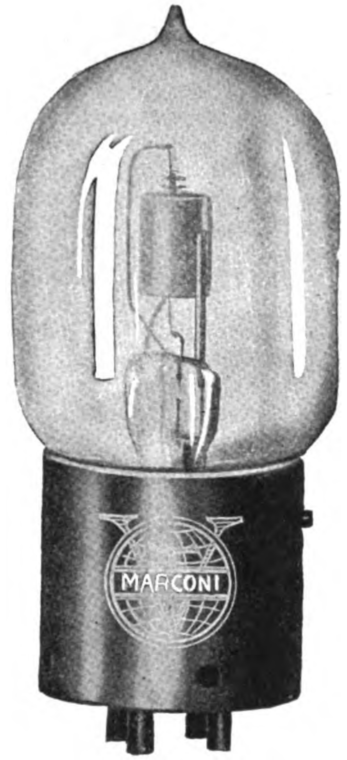

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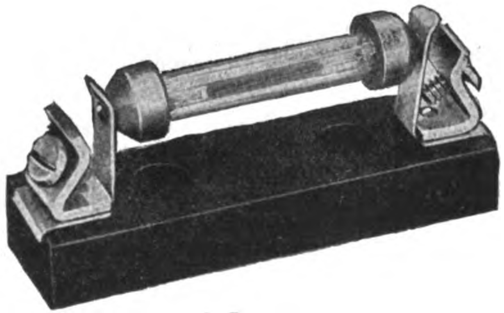

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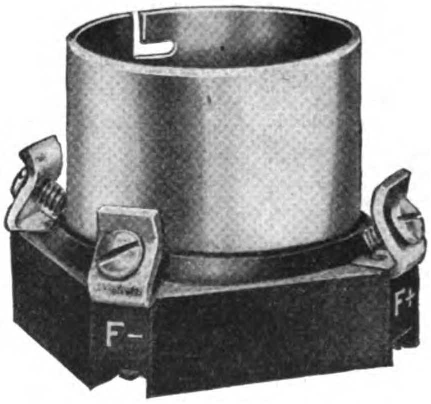

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principally in the type of coil used, the method of securing inductive coupling between wing and grid circuits, and in the mechanical arrangement of the antenna circuit and closed circuit inductance. The wing-grid coupling in this case is obtained by making a portion of the closed circuit inductance common to both wing and grid circuit. The amount of this common inductance is determined by the position of the "tickler" switch. Final adjustment for effective coupling between the two circuits is had by use of the bridging condenser which is shunted across the telephone receivers, but the primary of the amplifier determines if an amplifier is used. The control of oscillations thus provided is all that can be desired. This method has been chosen due to the fact that only two coils are required; that control of oscillations is equal to the control provided by any other method; and because the range over which oscillations may be secured is perhaps very much greater than any other method conveniently available. The use of a third coil in the plate circuit, the third coil being coupled to the secondary inductance, also provides a very good means of securing oscillations, and has been used in the later models of the Navy receiver. but unless considerable care is exercised, the electrical constants in this third coil are quite likely to be such that the third coil or tickler coil has a fundamental wave-length within the range of wave-length it is desired to receive. in which case the energy losses in the third coil at or near this wave-length will be so great that no oscillations are possible.

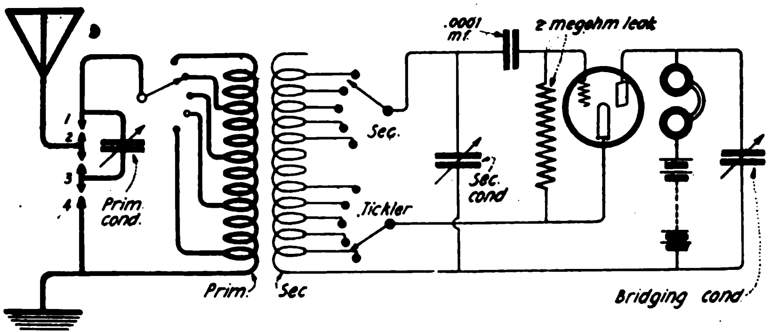

Figure 2—Theoretical wiring diagram for the long wave receiver

The coils are wound as follows:

Secondary coil: Winding form, 2½", outside diameter, 1¼" wide. Wind on 6 turns of .01" paper, shellac together, next, starting about 3/16" from edge wind on a layer of 32 turns of No. 20-38 Litzendraht, 22 S. C. C. or 22 D. S. C. This is then to be covered by one layer of 10 mil paper, the wire carried back to that side where the winding was originally started, and a second layer placed on, etc., etc., until 33 layers or a total of 1,056 turns have been wound on. Two or three layers of paper are then wound on top of the last layer of wire, shellaced, and the entire coil taped with cotton tape about ½" or ¾" wide. During the process of winding, taps should be taken out as follows: For secondary inductance switch, tap at 4 layers, 7 layers, 10 layers, 14 layers, 18 layers, 23 layers, 28 layers, and 33 layers. For tickler coupling taps should be taken out as follows: 15 turns, first layer, second layer, third layer, fourth layer, fifth layer, sixth layer, and seventh layer. All the secondary taps should be led to secondary switches in order, and all tickler taps to the tickler switches in the order that they are taken out; that is, the taps from the fourth, seventh, tenth layers, etc., in the case of the secondary, should be led to switch contacts 1, 2, 3, etc., and taps taken out at 15 turns, one layer, two layers, etc., should be led to switch contact numbers 1, 2, 3, etc.

The above method gives a coil which has been bank wound by layers. This method of winding decreases materially the distributed capacity of the coil and this distributed capacity is still further lessened by the introduction of a good grade of paper between layers. A coil manufactured in this way is a great deal freer from dielectric losses than a coil which is not bank wound and which does not have separation between layers, and it is the writer's opinion that the effort required for construction will be well repaid by the difference between the results obtained on a coil of this type and anything which can be purchased.

The primary coil is wound in the same manner on a form 3" outside diameter and 1¼" wide, 32 turns per layer, and 27 layers, taps being taken out at the end of the 3rd, 5th, 7th, 9th, 11th, 13th, 15th, 17th, 19th, 21st, 24th, and 27th layers, these taps leading to the respective switch contacts of the primary switch.

After the coils have been wound and taped, they should be baked in the oven for a period of one or two hours at a temperature not exceeding 200° F. at which time they should be removed and varnished immediately with a good grade of insulating varnish, or, if this is not available, with shellac made by mixing flake shellac with 95% alcohol. After varnishing, they

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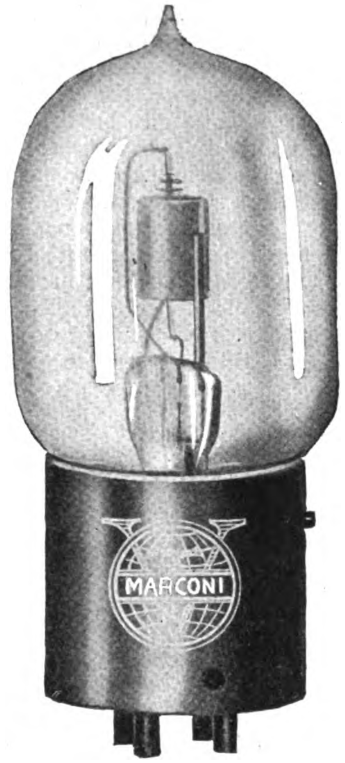

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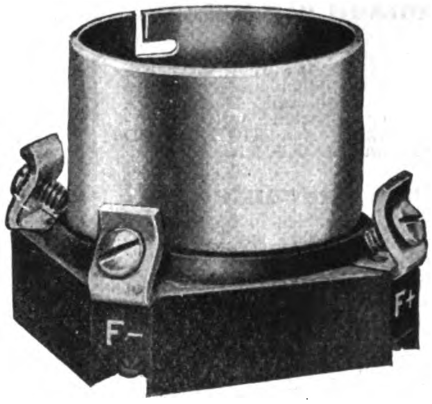

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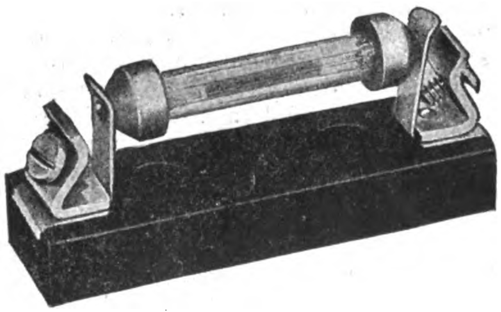

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should again be baked for a period of two hours or so at the same temperature, until the varnish is thoroughly dry and hardened.

This treatment insures a moisture-free and moisture-proof coil. The coils are then ready for use in the coupling device which is shown in detail in figure 3 where dimensions of the individual parts are also given. At maximum coupling, or 90° on the coupling scale, the two coils will lie in planes which are at right angles but the plane of the one coil does not cut the center of the other coil. If this were the case, the coupling between the two coils would be zero, but if off center, and both of them still in a vertical position, the primary coil may be so placed as to give the proper co-efficient of coupling for wavelengths within the range of this receiver, as is approximately the case in figure 1. At the maximum position or thereabouts on the scale (zero degrees) the coils are in parallel planes but do not have a common axis. The more nearly common their axes the greater the coupling between the coils when their planes are in parallel, but as their axes are separated the coupling decreases and reaches a minimum at that point where, if the coils were of the same size and same construction, the axes are separated a distance equal to the mean radius of the coils. The proper distance to be chosen between the axes of the primary and secondary coils when their planes are parallel (pointer at zero degrees) will have to be determined by experiment if it is desired to have zero coupling when the pointer stands at zero. The negative portion of the scale is provided in order that any electrostatic coupling between condensers or any electro-magnetic coupling arising from wiring, may be neutralized. This negative coupling will also take care of any miscalculation in the placing of the coils. That is, should the distance as shown in figure 1 prove incorrect with the particular coils which might be made up for this receiver any failure on the part of the device to provide zero coupling when the coils are in parallel planes, may be overcome by tilting the coils slightly one way or the other.

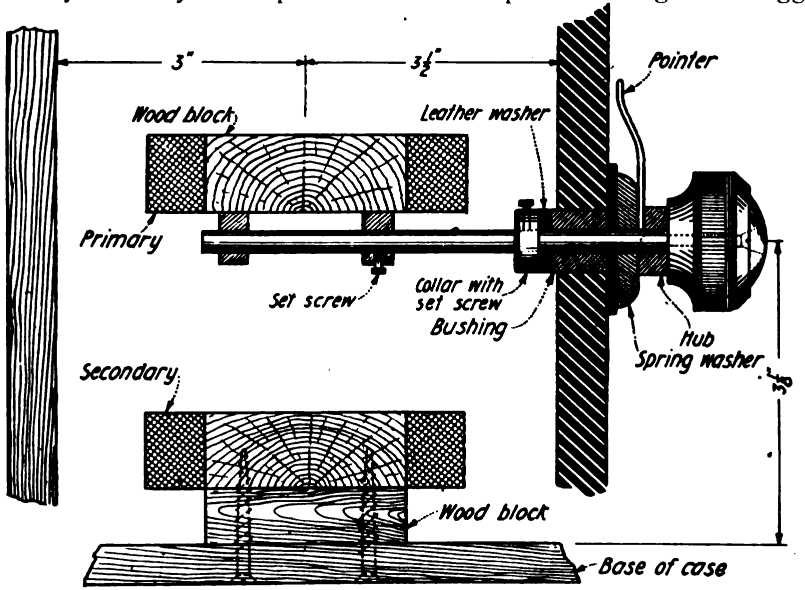

Figure 3—Coupling device shown in detail

For best appearance, the length of the coupler case might be made to equal the width of two variable condensers and the height of the case to equal the width of one variable condenser. A small audion panel may then be made to match, but if desired, it would be possible to make a large panel to include the coupler, the three variable condensers, and the audion panel, although it is suggested that from the point of view of utility, most amateurs will find it better to follow the method outlined. In the lower left hand corner of the main panel in figure 1, a telephone type of switch is shown. This is a double pole double throw switch and is used for throwing the primary condenser either in series or in shunt.

In operating this receiver, the following procedure may be observed. An arbitrary value of secondary inductance and capacity is selected and the tickler coupling increased from left to right until oscillations start. The beginning of oscillations will be indicated by a dull thud in the telephone receivers. If the tickler switch is carried still further to the right sometimes a howling or squealing will result, indicating that the coupling between wing and grid circuits is too great. Switch should then be retarded until this howling just ceases. Another indication of oscillations may be had by touching the finger to the grid terminal of the receiver. If a click is heard both when the finger touches and when the finger leaves the terminal, the circuit is oscillating. Any failure of oscillations to start may be due to an incor-

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rect value of bridging condenser, antenna coupling, tickler coupling, filament current or plate potential, assuming, of course, that the receiver is properly wired.

Once oscillating, the coupling is set rather close, and the primary circuit adjusted by the use of primary inductance and primary condenser until the primary circuit is in resonance with the secondary. This resonance point will be indicated by the fact that static and signals approach and pass through a maximum, but if there is no static or no signal, a click should be heard as the primary condenser carries the circuit through the resonance point, the strength of this click depending upon the degree of coupling between the two circuits, or, if the coupling is very close, two clicks may be heard, the first indicating that the secondary circuit has ceased oscillating due to the effective resistance introduced by bringing the antenna circuit into resonance, and the second click indicating that the secondary circuit has re-commenced oscillations after the effective resistance of the primary circuit has been removed. Generally speaking, comparatively low values of coupling between the two circuits give the best signals (close coupling increases the resistance of both circuits) and, of course, greater freedom from static or interference. By moving from tap to tap of the secondary inductance and by adjusting the tickler coupling and bridging condenser so that oscillations are at all times being set up, and by, at the same time, keeping the antenna circuit somewhere near the resonance point, it is possible to cover the entire range of the receiver and thus pick up and log for future reference, the various stations which may be operating.

Once a station is heard, primary, secondary, and coupling are carefully adjusted and finally, the tickler coupling or bridging condenser is decreased until a maximum signal is heard. It may then be well to further decrease the antenna secondary coupling, to retune antenna and secondary circuits and to make a final adjustment of the bridging condenser.

The above procedure has been outlined as applying to undamped wave stations. Damped wave signals may also be heard with the circuits in an oscillatory state, but the note of the spark signal will be changed due to beats occurring between the damped oscillations of the spark signal and the undamped oscillation generated in the receiver itself. If it is desired to receive spark stations on their natural spark tone, it is only necessary to reduce the tickler coupling or bridging condenser value to that point where oscillation of the circuit just ceases, at which time the natural spark tone will be evident.

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Second Prize—Long Wave Receiver

By L. M. Clausing

Ease of manipulation as well as high efficiency should be given consideration in the construction of a long wave receiver. Efficiency is quite often attained by the amateur, but ease of manipulation is usually sacrificed, often by the choice of a circuit using a multiplicity of condensers and loading coils. I recall that my first set required at least three loading coils and five variable condensers, all of which were scattered over a large table to avoid undesirable couplings. To some experimenters, the space factor may not be of importance but large loading coils and condensers provided with long handles to get away from the great sensitivity to capacity changes resulting from the proximity of the operator's body are not convenient for practical work and usually require a very critical adjustment.

Another consideration of great importance to most amateurs is the cost of construction and maintenance. When amplifiers are used, one "A" and one "B" battery should suffice for all bulbs. The potential of the grid in each bulb should be such that the greatest efficiency is secured without burning the filament at an excessive brilliancy.

A form of feed-back which does not require a change of adjustment for small changes in wavelength is also desirable, and when small feed-back adjustments are necessary they should not appreciably affect the secondary tuning.

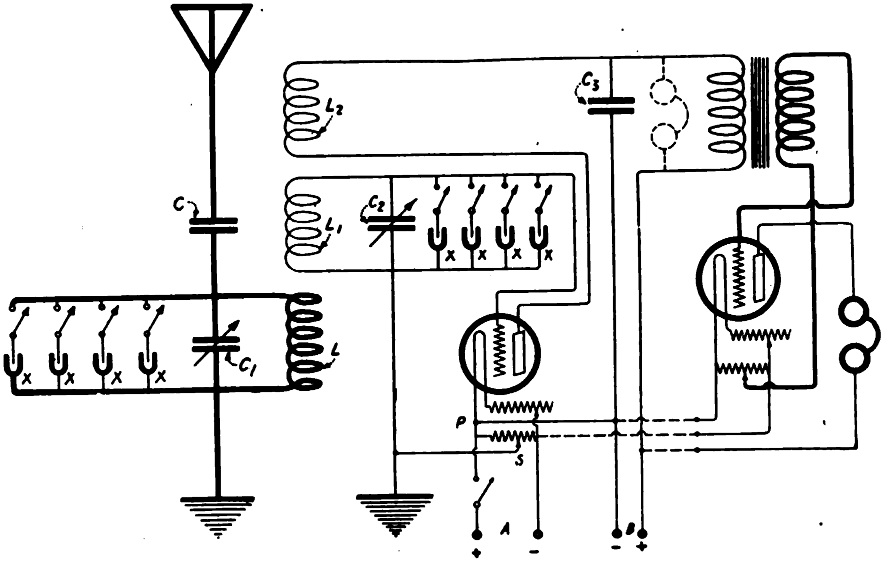

Figure 1—Circuit of long wave receiver with grid condenser displaced by the use of a potentiometer

In the circuit which follows, the grid condenser has been eliminated and the grid given the proper potential with respect to the filament by the use of the potentiometer P. The adjustment required for tuning to long wavelengths are accomplished by a

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variation of primary capacity C_1 and secondary capacity C_2. C is a fixed condenser of .00008 mf. P is a potentiometer with a total resistance of 100 ohms. The inductances L, L_1 and L_2 are of the new "honeycomb" type. They are small in size and the distributed capacity of the windings is sufficiently low for all practical purposes. Each of these coils has an inductance of 35 millihenries.

The condensers C_1 and C_2 have rotary plates so shaped that the capacity varies more nearly directly in proportion with the scale variation. Each condenser has a capacity range from .00002 to .0007 mf. The metal case of this condenser acts as an electrostatic shield and should be grounded as shown in the circuit diagram. C_3 is a fixed condenser with a capacity of .002 mf. and may be made with mica as a dielectric. Fixed condensers marked X have a capacity of .0005 mf. These also may have a mica dielectric.

The use of an amplifier is optional, but it is desirable in many cases where trans-Atlantic signals are to be received on a small antenna. With a two step amplifier, at my station, signals have been copied from the Nauen station in Germany *without aerial and ground connection.*

In operation, the receiver is wired exactly as shown. To operate, the filament is lighted, slider "S" moved near the negative end of the resistance P, inductance L_2 placed at a distance of 2" from L_1, L placed 3" from L_1, and the condenser C_1 varied over its entire range. If no resonance clicks are heard in the telephone receivers during this operation, reverse the leads connected to the terminals of L_2. Clicks will now be heard if all the instruments are connected as they should be. Such clicks indicate the presence of oscillations in the closed circuit and occur at the point where the primary is in tune with the secondary circuit. If there are two clicks widely separated, reduce the coupling between L and L_1 until just one click is heard. Also loosen the coupling between L_1 and L_2 to the point where it is just possible to maintain oscillations. When the proper adjustment for S is obtained, the distance between L_1 and L_2 may be as much as 6" to 8". For weak signals this last mentioned adjustment is best and needs only to be changed slightly for the entire range of wavelength.

The set is now ready for reception. To locate a station it is only necessary to vary C_2 and follow it up as indicated by the click from C_1. If the couplings between all three inductances are always fairly loose the settings for a station of any given wavelength will always be the same.

The fixed condensers, X, X, etc., may give place to variable condensers having a maximum capacity of .0025. In this case, adjustment for wavelengths below 7,000 meters will be somewhat critical.

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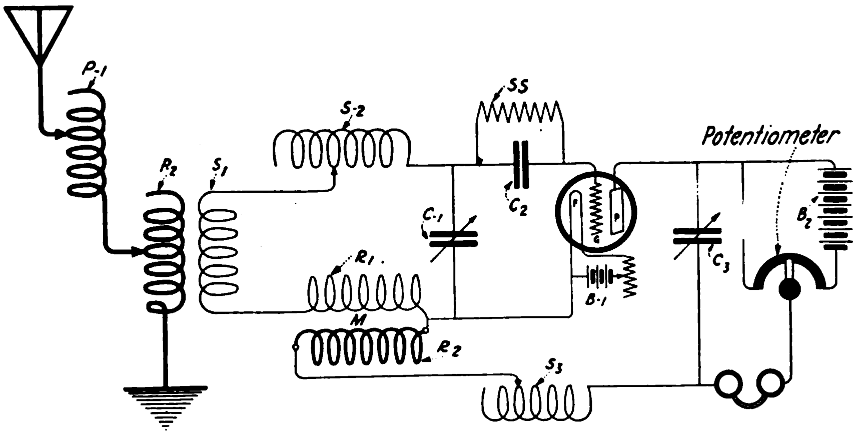

Figure 1—Showing wiring connections

Although an aerial span of two hundred feet or more is desirable for long wave work, it is not necessary. In fact the author finds little difference in the readability of signals on a 400 foot aerial and one sixty feet long.

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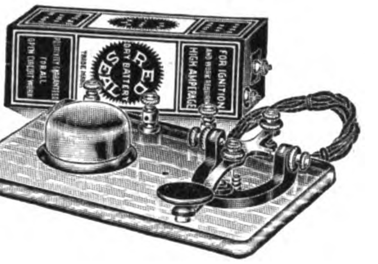

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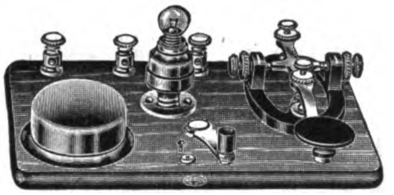

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With reference to the apparatus itself the connections as shown in either figure 1 or figure 2 may be used, figure 1 being somewhat better. The coil P-1 is the primary loading coil and may be wound with number 28 wire. The winding should be about 30 inches long on a tube about 5 inches in diameter. The primary coil P-2 should be wound with the same size wire as coil P-1 and should be 12″ long and 6″ in diameter. It should be closely variable, the slider being about the simplest method. The secondary S-1 should be about 12″ long and about 5″ in diameter, and should have 16 or 18 taps. This coil should be mounted so as to telescope into P-2. Secondary loading coil S-2 may also be wound on a tube 5″ in diameter with No. 34 wire and should be 36″ in length. S-3 is identical with S-2. The primary R-1 and the secondary R-2 of the regenerative coupler M should be made so as to telescope like a loose-coupler. No set size need be used for this coupler and any old loose coupler may be used if it is not convenient to construct one. A good size for one is: Primary 6″ diameter by 6″ long wound with No. 28 wire, no taps. Secondary 5″ diameter by 6″ long wound with No. 28 wire, no taps.

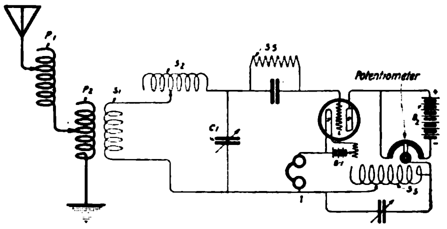

Figure 2—Modified circuit

The long coils should be tapped every two inches or so. Loops may be run through the walls of the tubes and then brought out to switches in a convenient place. This makes it unnecessary to break the wire from start to finish.

It is a rather difficult matter to wind the longer coils entirely by hand but if the builder will use a little ingenuity an arrangement can be worked out which will materially lessen his difficulties. Using a winder made from an old scroll saw the author once wound a coil 20″ long and 5″ in diameter in fifteen minutes. If access can be had to a lathe the coils may be wound in a short time.

In practice the three coils P-1, S-2 and S-3 may be of the same dimensions and No. 30 S. C. C. wire used throughout. Only one section of each coil need be tapped as the other sections of the coil may be cut either in or out and the tuning done with the tapped section. This is clearly indicated in figure 3. For any variation up to one full section set the switch B on point C and tune with switch A. For variation up to 2 coils and over one, set switch B on point D and tune with the switch A, etc., etc. Such an arrangement saves quite a lot of time and labor and is just as satisfactory as having the whole coil tapped.

No very definite sizes and dimensions are given above for the apparatus described. The builder will be able to meet the requirements from materials which he has at hand.

The variable condensers C-1 and C-3 may be either the large or small types well known to all amateurs. A large one is better for C-3. The condenser C-2 may be made of mica coated on each side about 2″ by 4″. A small variable condenser may be substituted. No bridging condenser is needed across the receivers although one may be used if desired.

A potentiometer is shown for the "B" battery regulation, but a switching arrangement may be used. Another feature of these connections is the grid leak "SS." This may be made of a piece of fibre about 1″ long and ½″ wide with a binding post at each end. It is connected in shunt to the grid condenser and a pencil line drawn between the posts. If the static or incoming signal is so strong that it paralyzes the bulb the "plugging" can be prevented by running a pencil between the posts until it stops. A line ⅛″ in width is about right.

The circuits are adjusted for oscillations by using very close coupling at M, and adjusting S-3 and C-3 until a click is heard both when the finger touches and leaves the grid binding post. This double click is an indication that the circuits are oscillating. The primary circuit is now brought into resonance with the closed circuits. By keeping these circuits more or less in resonance, and varying their wavelength, any undamped wave-stations which may happen to be sending will be heard. The undamped wave stations are in operation at practically all hours of the day, and consequently may be heard at practically any time one may care to listen.

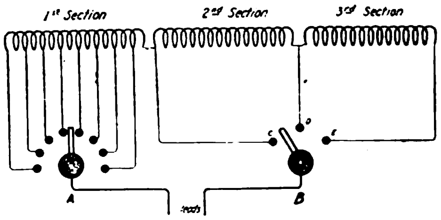

Figure 3—Method of tapping the coils

A modification of the circuit described above is shown in figure 2, where no regenerative transformer is used, and where the coupling between the wing and grid circuits is provided by the capacity of the telephone cords.

Jas. B. Holston—*Nashville, Ills.*

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Vacuum Tubes in the Army

THE radio experimenter who has not been in touch with the work of the Signal Corps during the war will be interested to learn of the progress made in the construction of the vacuum tube during the past two years. Prior to the closing of the amateur stations this device was used by the more advanced experimenters, but only for the receiving purposes, and at its best it still had certain defects.

Skilled engineers from several of the largest electrical companies have improved the vacuum tube from the make-shift device of two years ago, to one of the most useful and efficient instruments known to radio communication. The standard tube applied to the Signal Corps for receiving purposes has a number of features which are a distinct advance over any tubes the amateur has had access to, and in addition a transmitting tube of considerable power has been developed, and in such quantities that it should be obtainable at reasonable cost.

The standard receiving tube operates on the usual 4-volt filament battery and 40-volt plate battery, but it has operating characteristics much better suited for its use by inexperienced operators. No critical adjustments of either the filament current or the plate voltage are required, the tube being designed so that it is operative over a 20 per cent. variation in these values. Thus, the filament rheostat and plate potentiometer are eliminated, which is indeed a marked improvement. Again, the same tube will function equally well as a detector, amplifier, or oscillator, making it unnecessary to select different types of tubes for each specific purpose.

As an amplifier, the amplification constant ranges from 12 to 25 and two such tubes connected in cascade will give amplifications in the neighborhood of 500. It has been found, however, that a cascade circuit of more than three steps again introduce the unstable conditions of the earlier tubes, and to overcome this, resort was had to an ingenious device. The signals were amplified at radio frequencies for three steps, then a detector tube was introduced, and from its output circuit, the signals were again amplified three times, at audio frequencies. Using this combination of seven tubes, it is possible to obtain an increase in signal strength up to the current saturation of the tube. For such an amplifier 60 volts are required in the plate circuit, and 4 volts, 7.7 amperes for the filament.

Experiments were also carried on with the object of producing tubes that would require a minimum battery equipment. The engineers finally succeeded in designing some that require 0.2 ampere at 2 volts for the filament, and other tubes which operate efficiently with from 4 to 6 volts in the plate circuit. What a boon these tubes would be to the average amateur who is troubled with the question of adequate current supply?

The transmitting tube which was adopted as standard for our army in the field, was more difficult to design than the receiving type, but it shows the results of careful engineering. It requires 7 volts for the filament, and 250 to 350 volts for the plate circuit. It has an output of from 3 to 5 watts high frequency power. It found a wide application on the small airplane transmitters, and was also used as an amplifier tube in the receiving circuit where a greater power output was required.

Transmitting tubes of much higher powers have been designed for experimental purposes, one of which had an output of 30 watts high frequency current, and required a plate voltage of 800. Another had an output of 100 watts, with a plate voltage of 1,500, but it is unlikely that such tubes will ever find a wide application in the amateur field, owing to the difficulties attending the production of the high voltage current.

Much credit is due to the engineering experts who have achieved such remarkable success in this work of developing the vacuum tube.

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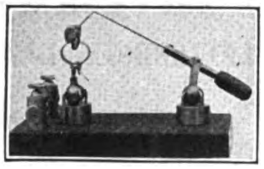

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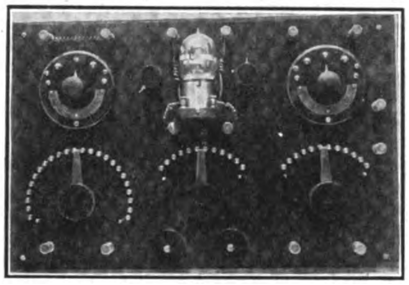

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O. E. S. Stanwood, Wash.

See answer to E. J. W. in this issue.

In the June issue of The Wireless Age, page 29, second column, the fifth line from the bottom, the word "each" should be omitted so that the line will read "a tap placed at 55 turns." Turn fifty of section 1 and beginning of section 2 are connected and form tap 1. Tap 2 is at 55 turns on section 2 or 105 turns total. Tap 3 is at end of winding. The ⅜-inch space is left to reduce distributed capacity on the lower wave lengths.

Figure 6, page 29, June Wireless Age, have the numbers 5 and 7 erronously transposed in the winding diagram.

* * *

E. J. W., Roxbury, Mass.

See reply to O. E. S. in this issue.

The coil you wish to use is wound with Litzendraht and No. 18 D. C. C. wire on a tube 3 inch outside diameter. A four banked winding is used as shown in figure 6, page 29, of the June issue. A section of fifty turns is wound on the spool and a space of ⅜ inch is left after which another section of 240 turns is wound on with the tap placed at 55 turns.

In the next to the last paragraph, page 29, the word "each" before the number of turns, should have been omitted.

* * *

P. A. H., Pawtucket, R. I.

The diagram shown on page 41 of the July Wireless Age is incorrect in that the wire running from the 20,000 ohm resistance to the double pole double throw switch should not be shown as connecting to the ground lead.

* * *

M. W., Troy, N. Y.

Satisfactory results for calculations such as yours may best be obtained by the use of Nagaoka's formula (see August, 1915, issue), rather than Cohen's. You seem to have failed to convert your dimensions into centimeters in all cases. The inductance of a coil 4 inches in diameter by 1 inch in length wound with a single layer of 30 turns is approximately 125,000 centimeters.

From dimensions given in figures on page 27 of the May issue, you will yourself be able to calculate the various inductances which go to make up the receiver there described. In the case of the ball, it may be considered as a cylindrical winding 2¼ inches long and having a mean diameter of 3 15/16 inches, the spacing in the center being disregarded. Each pair of field frames may be treated in like manner. Your results will be sufficiently accurate for all practical purposes. If you use No. 32 wire throughout the secondary circuit of your receiver, its efficiency will be considerably decreased since resistance rises rapidly at the higher frequencies. Otherwise the receiver should operate in a very satisfactory manner.

* * *

W. G., New York City.

See article to appear in October issue on "A Two Stage Amplifier Cabinet."

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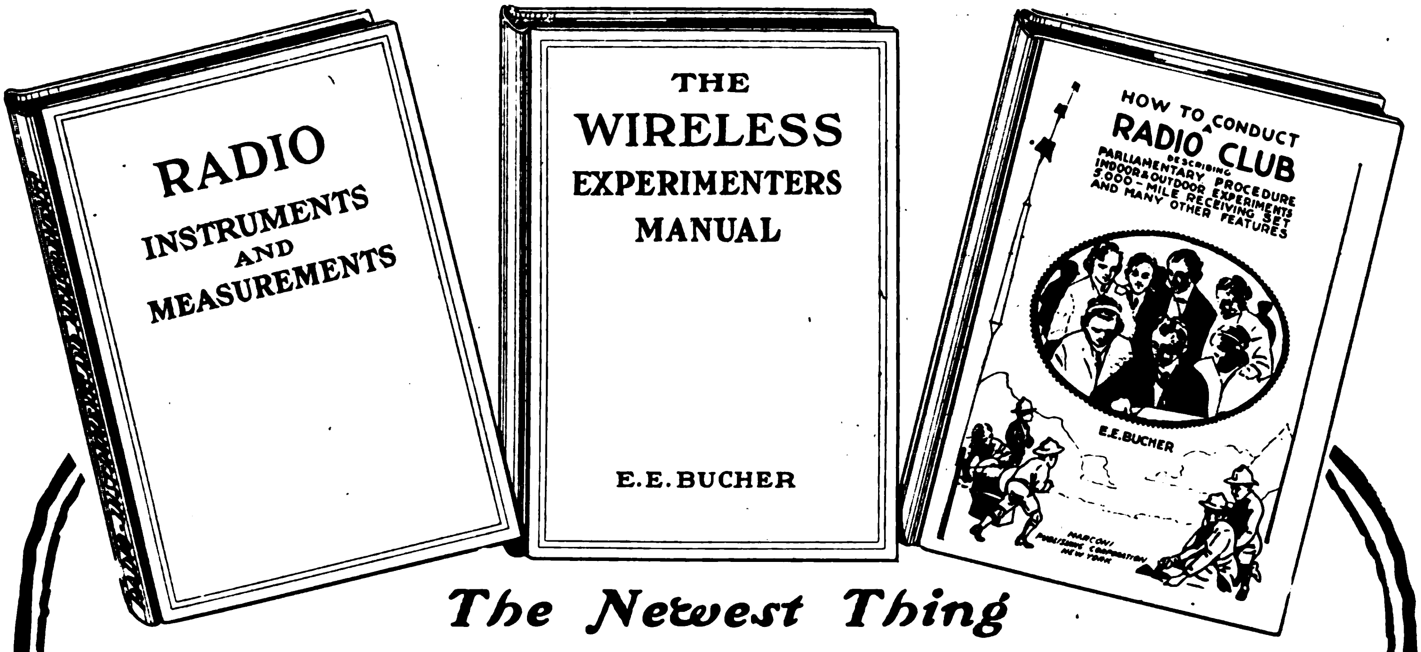

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H. H., Atlantic City, N. J.

Cells of the "A" and "B" for the vacuum tube detector you mention should be in series.

Castor oil may be used in a condenser to increase the capacity of the condenser, the specific inductive capacity of castor oil being between 4.5 and 5 times that of air. Other oils, such as lubricating oils of various qualities, may be used. A particular good grade of oil which may be used in the case of transmitting condensers, is "Nujol," which may be purchased at any drug store.

The newspaper clipping which you enclose, refers to a loop aerial, but a coil such as you have mentioned, that is No. 18 copper wire wound on a frame 1 ft. square and 7 feet in length, would not make a good one. It would be better by far to make a frame 7 feet square and 6 or 8 inches in width.

An article will be published in this magazine in the near future on loop construction and the use of the loop for transmission and reception.

* * *

H. W. N., Victoria, B. C.

A fairly complete list of high power arc and spark stations with their wavelengths, is being published in this issue.

* * *

R. W. P., Detroit.

As Mr. Dean gave no dimensions for the condenser test tubes which he described in the November, 1916, issue of Wireless Age, it is impossible for us to say exactly what the capacity of the condenser would be. You will be safe, however, in figuring that it is somewhere in the neighborhood of .0003 mf.

* * *

M. B. DeL., Annapolis, Md.

The limits of amplification using three electrode vacuum tubes, vary with the type of coupling used between the tubes and the precautions taken to prevent extraneous and undesirable back-coupling, be it either electrostatic or electromagnetic, between the first tube or tubes in the circuit and later tubes. After a certain amount of voltage amplification has taken place, electrostatic or electromagnetic fields are set up due either to the concentrated windings of the coupling transformer or to the wiring, and sooner or later these stray fields will link the fields having to do with the wiring, or transformer of the first tube and oscillations will result. These oscillations are uncontrollable under these conditions and consequently the amplifier is no longer useful. With proper methods of shielding the various stages of the amplifier from these undesirable fields amplifications of the order of 100,000,000 times have been effected. With the ordinary methods of coupling tubes and where no effort is made to guard against magnetic and electrostatic fields existing in them, the order of amplification reaches a limit somewhere around 1,500 times.

The action taking place in an arc transmitter after the striking of the arc and up to the time when steady oscillations begin, results in a hissing, sputtering and bubbling noise in the telephone receivers at a station which is in tune with the arc transmitter. This hissing, sputtering and bubbling is due to the very rapidly changing conditions present in the arc chamber when the arc is struck. The arc will not act at all steadily until that time when the exactly proper atmosphere has been attained in the arc chamber. The nature of this atmosphere depends upon the temperature and upon the amount of alcohol which has passed into the vaporizing chamber from the supply reservoir. During this period of adjustment the arc is at all times endeavoring to supply oscillations, but due to lack of proper temperature, or as above stated, the proper mixture in the chamber, the oscillations are choked out, etc., until finally the temperature having reached the normal operating valve and the proper mixture having been attained, steady oscillations commence.

The modulator member of a two-tube radio telephone outfit acts simply as an amplifier of voice currents passed into the microphone. These voice currents, after having been amplified, are superimposed upon the radio frequency oscillations of the oscillating member of the outfit.

* * *

R. Y., Toronto, Ont.

While a vacuum tube is oscillating there is not necessarily any sound in the telephone receivers, but if while oscillating, a finger is touched to the grid terminal of the receiver and removed again, a click will be heard in the telephone receivers both when the finger touches the terminal and when it is removed, but if the receiver is coupled to an antenna, the characteristic note of spark signals or static will be changed to a hissing, scratchy note. Inasmuch as there is usually more or less static of one character or another, this serves as a fairly reliable indication.

The loose coupler which you describe has a calculated primary inductance of about 45,000,000 centimeters and a calculated secondary inductance of about 75,000,000 centimeters, which being the case, you should be able to receive wavelengths up to 15,000 or 16,000 meters provided your secondary was shunted by a maximum capacity of .001 mf. and provided your antenna was of sufficient size, or a loading inductance was used to make up for what the antenna might lack.

The hook-up which you enclose is not considered the best hook-up for undamped wave reception, due to the fact that the control of the oscillations generated by the vacuum tube is not what it should be. You will find articles in the September issue which will give you preferred schemes of connections, with which you should be able to receive any of the Trans-Atlantic stations on an 85-foot antenna.

It is difficult to say which vacuum tubes are the most sensitive inasmuch as they vary considerably in sensitivity. You will probably find your tubular audion to be as good as any.

* * *

K. E., Seattle, Wash.

If you have in mind the construction of a receiver such as described by Mr. Jones in the June issue, it will not be as satisfactory to wind the inductance in five layers, and not advisable in any case unless the wire is wound on in banks. We suggest that you refer to articles being printed in the September issue, covering construction of long wave receivers, if you desire to build a receiver which is more compact than the one above mentioned.

The comparative values of inductance in the primary and secondary circuits will depend entirely upon the antenna used; that is, its size. For the average 200-meter amateur antenna, the inductance values in these two circuits will run about the same, excepting where a shunt condenser is used in the primary circuit under which condition the primary inductance would not need to be as large as the secondary inductance.

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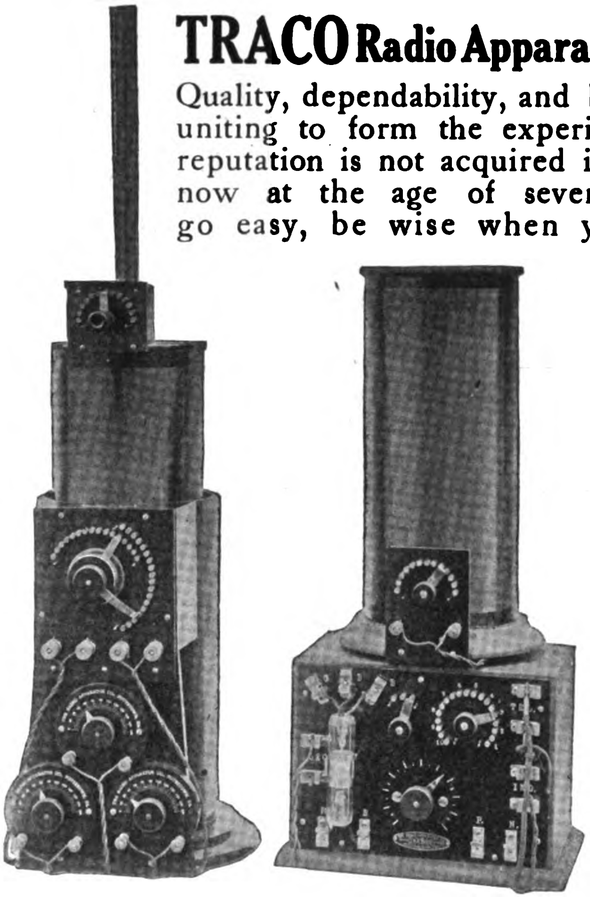

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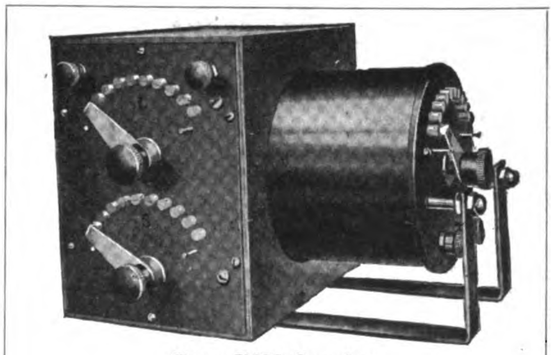

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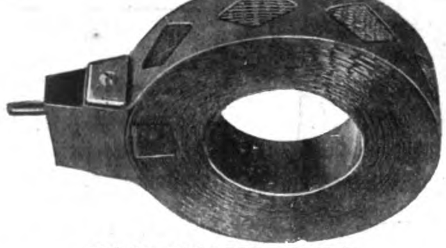

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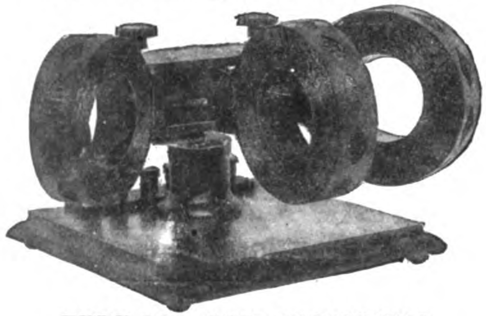

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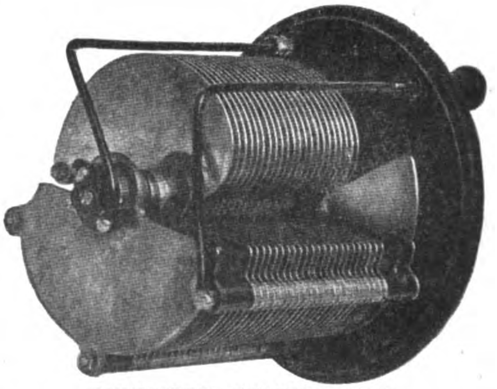

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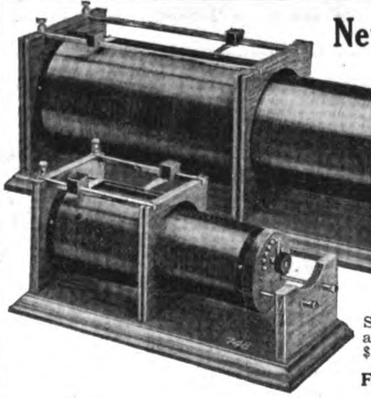

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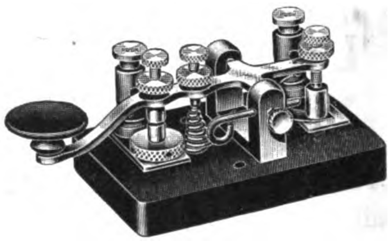

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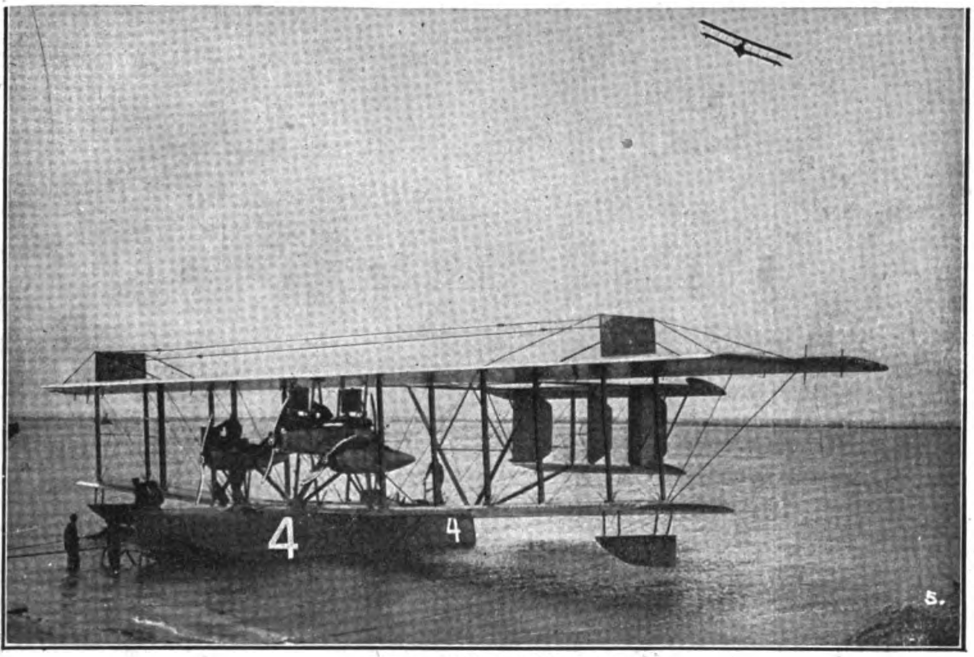

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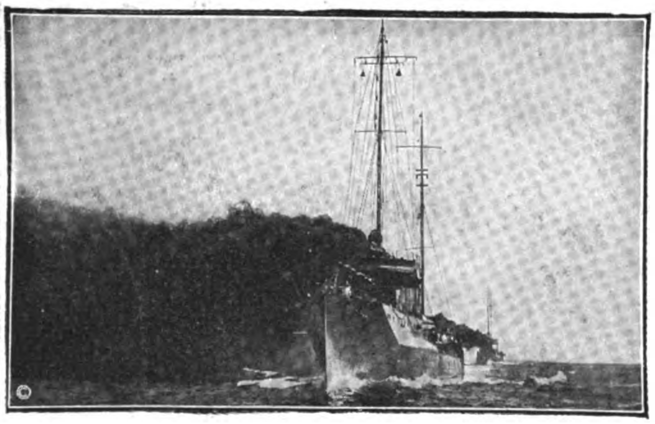

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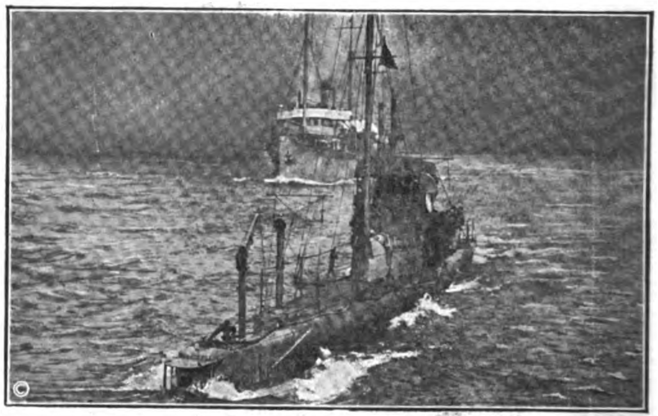

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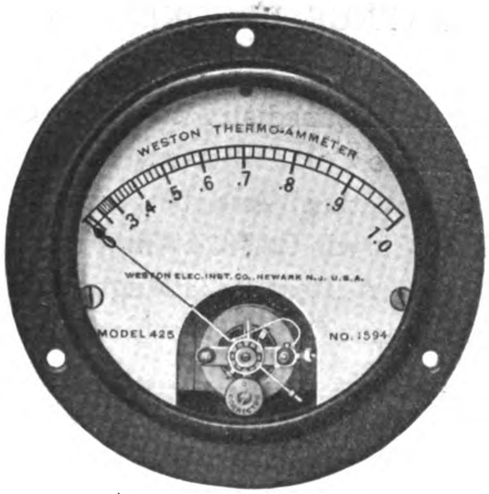

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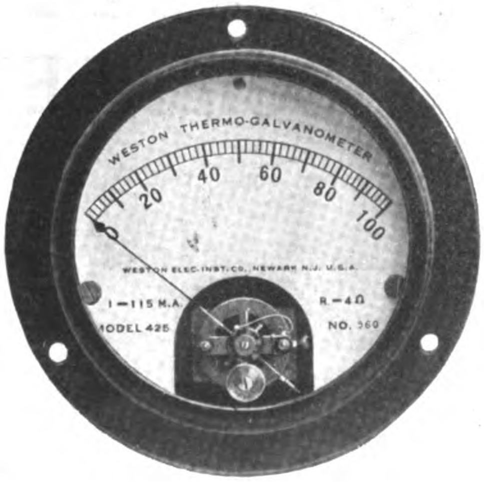
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Vol. 7 No. 1

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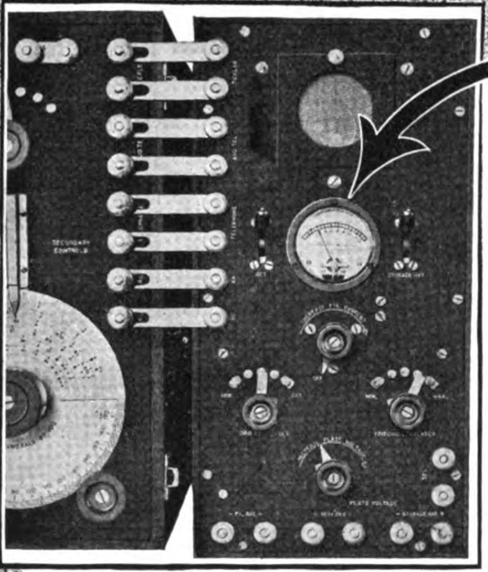

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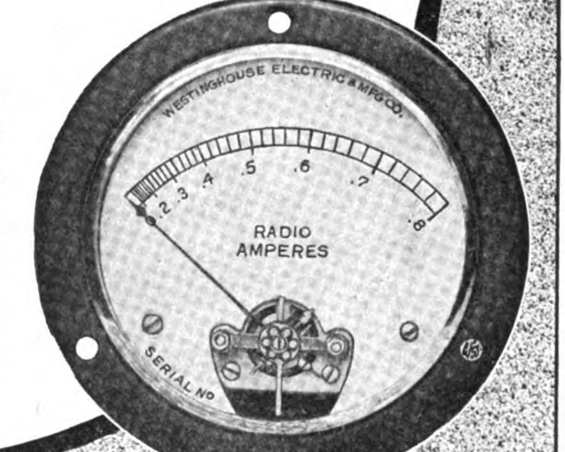
was especially developed for Radio application. Operating on the D'Arsonval principle, it will measure vacuum-tube filament currents and other direct currents used in wireless work, while for radio frequency currents it is provided with a self-contained heater and thermocouple.



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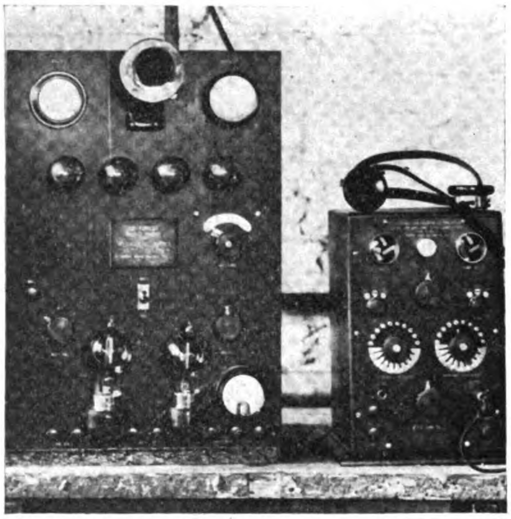
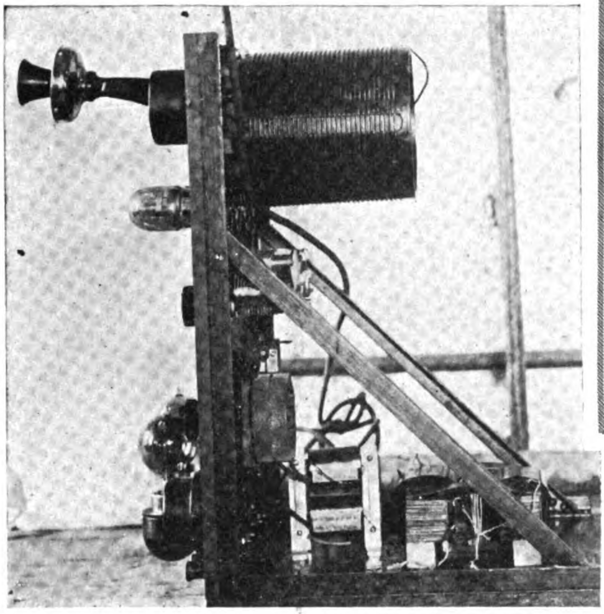
A NEW 'PHONE

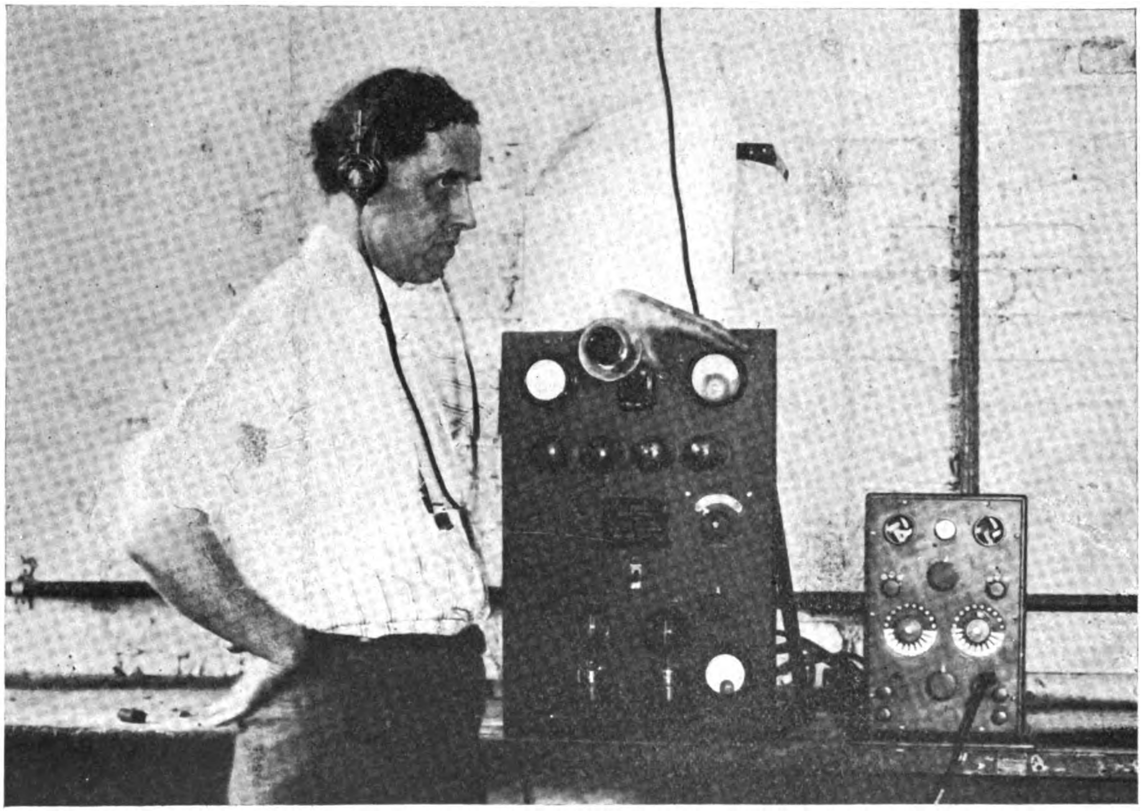




Above: The transmitter, and on the right the combination V. T. detector and amplifier

To the left: Assembly of the apparatus as seen from the side of the transmitter panel

Graphic News



The complete wireless 'phone set, plugged into an ordinary electric light socket. The transmitting range is said to be from ten to twenty miles, according to conditions

Vol. 7. No. 1. OCTOBER, 1919

THE WIRELESS AGE

WORLD WIDE WIRELESS

The Unprecedented Demand for Wireless Operators

THE United States Shipping Board is in immediate need of qualified radio operators, and can furnish employment to any man who possesses a first grade commercial license issued by the Department of Commerce. In accordance with the new wage scale recently established, the first operator is paid $125 per month, the second operator $100 per month, in addition to all expenses. The radio operator is considered an officer and is provided with superior accommodation.

All Shipping Board vessels carry one or two radio operators. When a ship carries two operators an experienced man is generally put in charge as first operator, with an assistant as second operator. In case the ship only carries one operator, he is usually rated as first operator, and should be a man who has made at least one voyage. During the war, a large number of radio operators secured training at the expense of the Government for both the army and the navy. Any of these operators who desire employment have only to secure a commercial radio operator's license, issued by the Department of Commerce after passing the required examination.

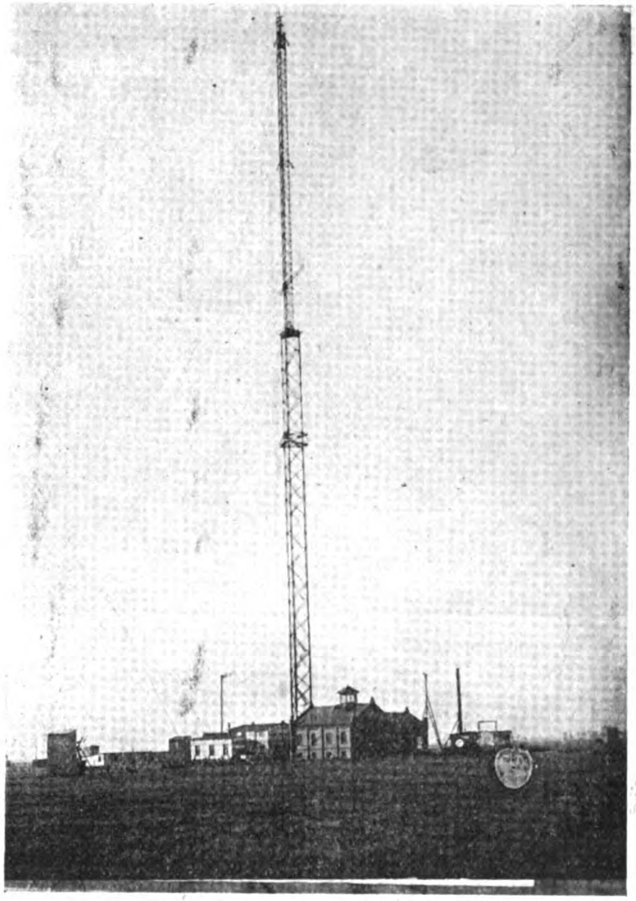
* * *

Foreign Trade Council Opposes Government Operation of Wireless and Cables.

THE National Foreign Trade Council's committee on Foreign Communications has declared strongly in favor of the establishment and maintenance of adequate systems of transoceanic communications under private enterprise and for the speediest possible release of Government control of such private commercial systems as have not already been returned to their owners.

At the same time the committee took measures looking to the early establishment of additional means of communication across the Pacific so as to bring to an end as promptly as possible the present intolerable conditions in transpacific cable and wireless communication. The committee went on record as definitely opposed to Government ownership, control or operation of commercial systems of cable or wireless in time of peace; but pending the return to private operation of such commercial systems as are still under Government control, the committee favors the continuance of the Naval Radio stations in commercial service, in order to afford as much relief as possible from present conditions, especially across the Pacific. It was brought to the attention of the committee that there is a tendency in different Government departments to use cable or wireless at times for communications more or less routine in character and that such traffic increases the delay in transmission of commercial messages that are essential to the transaction of important international business.

The committee called this situation to the attention of the President and to the heads of various Government departments with the request that the volume of Government business which now takes precedence over all commercial business shall be reduced as far as practicable, and that Government messages which are not urgent should be transmitted without the right of precedence over commercial business.



Tower of the Nauen station from which messages are sent direct to America

British Aircraft to Have Use of Government Wireless

AT a recent meeting of those interested in commercial aircraft held in London to discuss with representatives of the Air Ministry the ultimate disposal of Government airships Maj. Gen. Seeley, Under Secretary for Air, who presided, said that the Air Ministry and Admiralty would offer existing machines and those in various stages of construction to those who would undertake the formation of commercial air schemes.

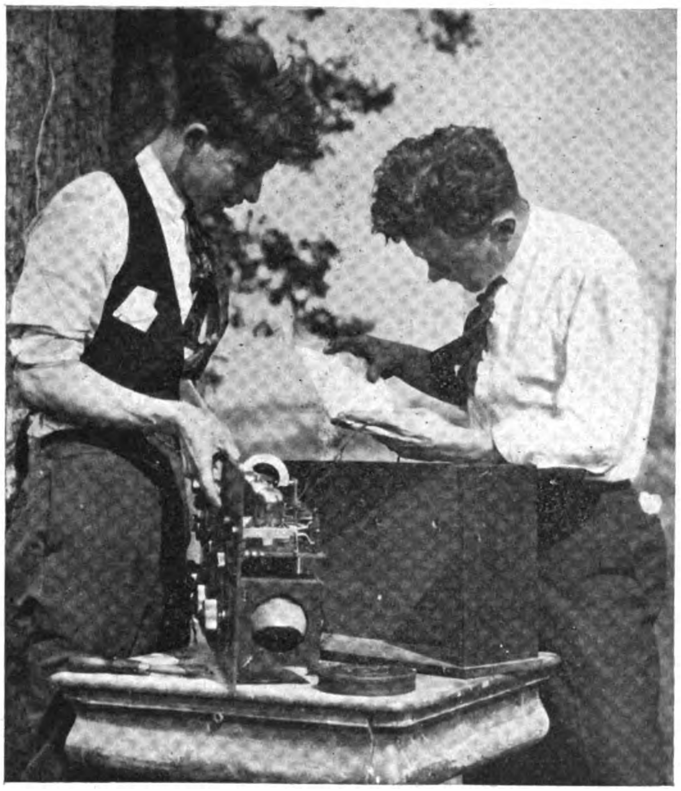
The Government's assistance would include the use of wireless stations.

Belgian Girl Who Destroyed Enemy Wireless Visits U. S.

MARIE LOUISE GOMBIER, a Belgian heroine, wore the Croix de Guerre with two palms when she came ashore recently from a French steamer.

Her war record began when, with two other girls, she escaped from Brosges convent, which was surrounded by Germans, and fled to her father's home in Brussels. Two days later the Germans entered Brussels and a German officer was billeted in the Gombier home at Dickebusch farm. A wireless plant was installed.

One day when the wireless room was left unwatched, Marie slipped in and broke the delicate machinery with her shoe. It took forty-eight hours to repair the damage. Marie made a second attempt at sabotage, using a bottle for a hammer.



The popular wireless novelty of experimenting with tree antennae

She had partly wrecked the plant when two soldiers caught and beat her. An officer ordered her to be shot, and only by the intercession of the officer billeted in her home was the sentence changed to imprisonment.

For five weeks she was kept prisoner with two French soldiers in a cart. While the cart was on its way to the rear of the German lines the Ninety-fifth Canadian Regiment arrived and Marie escaped.

China Protests Against Japanese Stations

IT is announced from Shanghai that, under the guise of trying to get actual practice for their wireless engineering students, the Japanese have established a wireless station at Kung Tsuling, Feng Tien, Manchuria. The station is in the railroad zone of South Manchurian Railway and is surrounded by barracks. It is fully equipped and in constant communication with Japan.

Asserting that this is a violation of the Chefoo cable agreement, wherein Japan pledges not to establish wireless stations in China, the Chinese Government has vigorously protested. Japan has another wireless station in Chinese territory at Hankow.

Swedish Engineering Party Uses Wireless

WORKING parties engaged in regulating the Lule River, Swedish Lapland, are keeping up communication by wireless, the first recorded use of it for practical purposes in Sweden. This avoids the risk of telephone and telegraph communications being cut by snowstorms or avalanches.

Uncensored News to the Orient via Radio

AMERICAN news for the Orient will hereafter be sent free of charge by the United States Radio Service. The arrangement is the result of many months of effort to free American events and policies from the censorship and filtering processes used by the foreign governments, to further their own trade interests.

News will be handled by radio to the Orient through Honolulu, Manila and Vladivostok, for a further relay by the latter port to Peking and Shanghai.

Wireless 'Phone Reports Forest Fire

FOR the first time, probably, in the world, a wireless telephone instrument has been installed successfully on the top of a large mountain for communication with stations below.

Early in August, so the story goes, Elijah Coalman, lookout on the summit of Mount Hood, stood 11,125 feet above the level of the sea, silhouetted against the white of a snow bank and spoke eagerly into a small black instrument. G. C. Maroney, his assistant, waited impatiently by his side.

C. M. Allen, telephone engineer, United States forest service, stood eight miles away and held a wireless telephone receiver in his hand. He was 7225 feet below. Every word spoken was clearly heard. A fire on an Indian reservation was reported.

The installation is more than a successful scientific achievement on the part of the United States forest service. It is a long sought source of protection against forest fires, a guard with an eye that can see hundreds of miles and a voice that can shout, if necessary, all over two states.

Power will be supplied for the time being by storage batteries. Later on wind-mills will be erected to utilize the powerful wind always present on the mountain top.

Flying Club Proposes Cross-Continent Radio Chain

THE American Flying Club has inaugurated a radio information service with a view of keeping the general public and newspapers in touch with aerial activities, according to an announcement made by the club. A wireless set has been installed in the New York clubhouse, and with its automatic recorder has been picking up wireless flashes from transatlantic vessels.

"We have arranged to furnish individuals and newspapers in the various cities with all information of aeronautical activities," an officer of the club said. "Each city will have a radio station assigned to it to give immediate reports of aviation events on schedules of every half hour. In this way we hope to stimulate public interest in the development of aviation in this country."

New Military Station for the Border

IT WILL be but a short time until the new military wireless station at Fort Brown, Texas, is finished and placed in operation. It is said to be the most powerful station on the Mexican border.

Wireless in the A. E. F.

First Authentic Account of the Organization of the Radio Division of the Signal Corps and an Inside View of the Great Obstacles which Americans Had to Overcome

By Lieut. Col. L. R. Krumm
Officer in Charge Radio Division, Signal Corps, American Expeditionary Force
and Capt. Willis H. Taylor, Jr.
Co-ordination Officer, Radio Division, Signal Corps, A. E. F.

Part II

"OUR telephone lines were cut beyond repair by shell fire; radio was relied upon to maintain the necessary liaison."

Such was the tribute paid to wireless communication in many of the reports of major and minor engagements of American troops which were submitted to the Chief Signal Officer of the American Expeditionary Forces. It emphasizes the importance of radio work.

The goal, at which all efforts were aimed, was to make radio communication a reliable means for maintaining liaison during emergencies in battle. Types and kinds of equipment to be used were the first consideration. Close upon this, in order of importance, was organization of the operating personnel and the formulation of instructions for operation of the equipment, comprehending such details as call letters, wave-length assignments and traffic regulations. These details were of the greatest order of importance in carrying on radio communication efficiently and with the least possible interference.

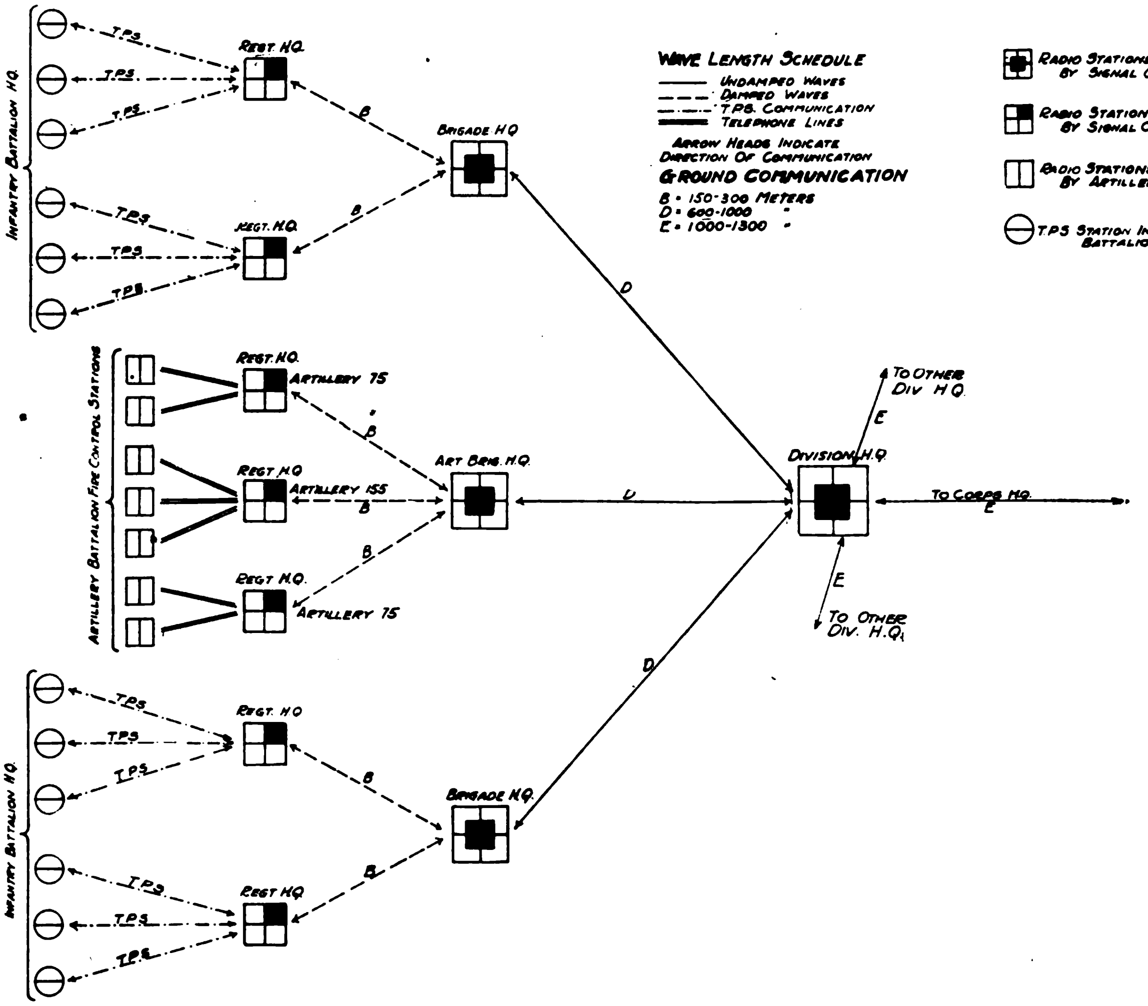
A Ford Tractor equipped with the Divisional Headquarters Radio Set Type E-3 or Type E-3 bis.

In a previous article it was pointed out that French apparatus had been adopted as the standard radio equipment for all American units, pending the development and production of equivalent material in the United States. This French equipment proved satisfactory in most respects, although the material used by the first of our troops left much to be desired, but as the war progressed and the later types of vacuum tube undamped wave sets came into more general use in our army the radio service became increasingly more satisfactory. These later sets reflected the long experience of the French army with radio communication, and also divulged the fact that the French engineers were considerably more conversant with the possibilities of the vacuum tube than we anticipated. In the circuits presented with this article the same tube was utilized for both transmitting and receiving. An innovation that immediately attracted the American signal officer's eye was the high frequency amplifier circuits developed and used by the French. At the time of our entry into the war, high frequency amplifiers had not passed the laboratory stage in the United States. In France they were being extensively used in the field, and with complete success. It is interesting to note that the British army took up the development of this type of amplifier with wonderful success and reports were current of a 19-stage amplifier in use by a land station in England which copied the bridge buzzer sets of the German fleet at anchor in the Kiel Canal — the Huns being so confident of their security from a wireless standpoint that they transmitted in plain German, much to the edification of the British Admiralty.

However, at the beginning, great was the scorn of the American operator—who had probably been a progressive amateur at home—when he was assigned to operate a spark set working on a plain antenna circuit. This type of equipment was used throughout a division at the beginning of our activities. In the trenches they were operated with an antenna elevated only about four feet above the ground, as shown in the illustrations, and were not very effective when so used. Higher antennae were possible at brigade and division headquarters, however, and here they were surprisingly effective, considering the amount of interference that naturally resulted from this type of equipment. Immediately, the American propensity to experiment became evident and it was indeed an exception to find a station in which the operator had not constructed loading coils to enable him to receive communications from Eiffel Tower on 2,500 meters, although his receiver was only intended for a maximum wave-length of 550 meters. Many a case of complaint against a station for not replying to a call was gravely answered by the commanding officer with the statement that the fault could not be with his station as he had about that time received a copy of the French communique from his operator, showing that he and his set were effectively operating. The fact that the station was 2,000 meters off the wave-length of his net meant nothing in the busy life of a non-technical officer.

It must be kept in mind that under no other condition do the best laid plans of men go so much agee as in warfare, so in contemplating the carefully outlined plans shown hereafter, it must be kept in mind that radio, like all other branches of the army, was usually greatly disarranged from the operating plan. Under these circumstances it is obvious that the best radio man in wartime is one who can meet conditions as they arise and maintain communication in spite of all contingencies; and it must be said that the resourceful man was nowhere more in evidence than in the radio work of the army.

DIVISION RADIO NETWORK



The French radio authorities, like ourselves, had the impression that vacuum tube sets were too complicated and frail for use except at considerable distances back of the line, and only the simplest spark sets were in use when our troops first went into the lines. Later, undamped wave sets were put in use down to and including brigade headquarters, and in the Argonne many of these sets were with the front line troops accompanying brigade commanders who wanted their headquarters up with the very foremost.

The supply of the necessary storage batteries was perhaps the most difficult question which arose in the operation of our radio stations. The hand generator used with the American army's pack set never was very popular, but it at least saved our army in its previous military efforts from one of the hardest problems we encountered in France. Charging stations were erected for each divisional area, and in special cases, with brigades. From these centers, storage batteries were distributed by automobile, motor-cycle, and by men—and in a few cases by airplane—to different units. In trench warfare they were delivered to the forward stations at night.

All French sets were operated from storage batteries with the single exception of a bicycle driven set which was used to a very limited extent. At first thought it might seem that the use of storage batteries as the primary source of power for wireless sets was entirely impractical, and so it first appeared to us. But their extensive use and the resultant type of radio equipment were entirely due to several years of trench or stationary warfare, a condition which affected our Allies' perspective. After their use was thoroughly established and the moving warfare stage developed it was then too late to change; a system of supply was developed in emergency, however, that was effective far beyond what would seem possible. The Germans used storage batteries, but they had also developed and were using many spark sets in which the power was provided by a gasoline engine and generator.

The details of organization of the radio operating personnel and the actual operation of the radio equipment in the various networks were so inter-related that no attempt will be made to discuss each one separately. Instead, an outline of the scheme of radio networks and wave-length schedules is given, through which one can arrive at a fair understanding of the details of the organization.

In the beginning—that is the beginning for the Americans—everything seemed simple enough. We had but few divisional artillery regiments equipped, practically no combat or observation airplanes, no anti-aircraft batteries or sectors, no railway or other heavy artillery, and no tanks. Our wave-length schedule and transmission systems were not complicated by innumerable networks and the radio communication system was briefly as follows:

Interior of a Ford Radio Tractor for Divisional Headquarters showing the Radio Set Type E-3 bis mounted therein

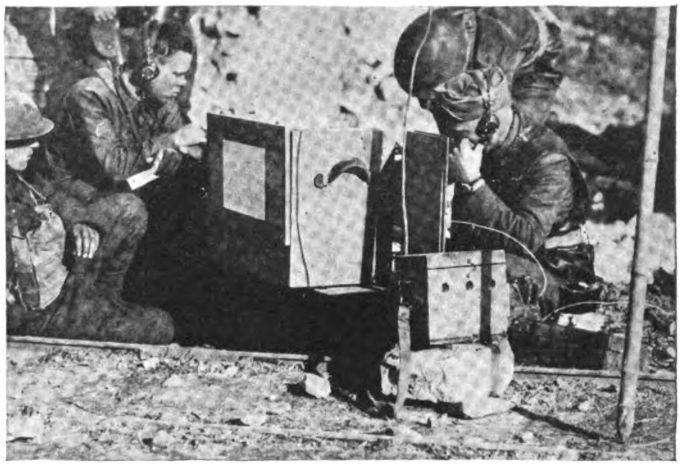
Ground telegraphy (T. P. S.) was provided for communication between regimental headquarters and battalion headquarters. The induction coil, plain antenna set, which will be described, was provided forward of divisional headquarters and down to regimental headquarters; undamped or continuous wave transmission was used between adjoining divisional headquarters and from divisional headquarters to army corps headquarters. At this time the army as a unit had not been organized; for that matter, army corps were novelties even in the early summer of 1918.

The divisional artillery was expected to have its shell fire controlled by radio from French observation and fire control airplanes, but it was sometime before satisfactory operations of this kind were obtained; more success was attained when American airplanes and operators worked with our artillery.

The wave-length assignments called for the allotment of 150 to 300 meters to regimental and brigade headquarters. This small wave-length range of 150 meters, together with the transmitting set, portable type, No. 4 (the small, plain antenna set already referred to) was the bane of many an otherwise religious sergeant's existence. The only way to change or adjust the wave-length was to change the height or the length of the antenna. A chart was actually compiled and distributed to some units showing what wave lengths would be obtained when an antenna of a given length was stretched between the 4-foot supports—providing, of course, that you had not lost the supports. Consider that divisional headquarters had to communicate with its three component brigade headquarters, two infantry brigade and one artillery brigade headquarters; also consider that each infantry brigade had two regimental headquarters and that the artillery brigade had three regimental headquarters. To this day it appears nothing short of miraculous that any reasonable continuity of communication was established through the interference. But it is a fact that, while the brigade and regimental interference was bad, divisional, brigade and regimental messages were successfully transmitted and received.

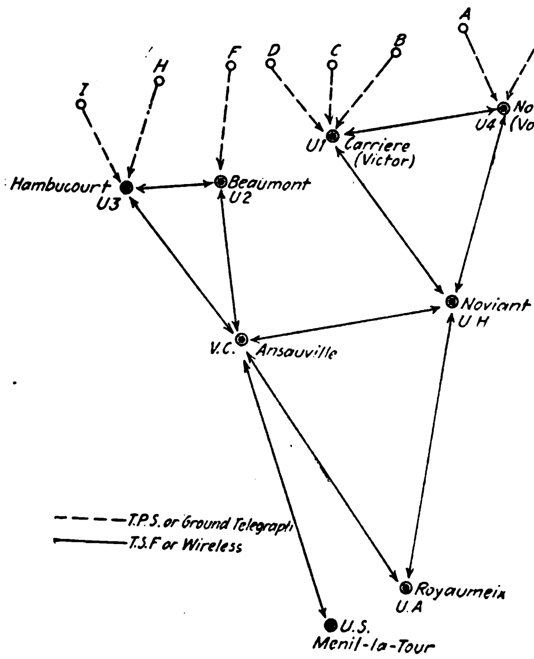
The undamped wave radio transmission between divisional headquarters and between divisional and army corps headquarters worked well from the beginning. The wave-length range assigned for this continuous wave communication was 600-1000 meters, giving a working range of 400 meters for this important radio service.

The equipment used for this service and wave-length assignment was a transmitting and receiving set known as Radio Set Type E-3. It was mounted on a Ford truck as shown in the photographs accompanying this article. These Ford trucks were originally ambulances, but were the only suitable vehicles available at the time we entered the war. One truck carried the radio equipment and a second one the charging set, extra storage batteries, charging switchboard and cooling tank for the water-cooled gasoline engines. The little flivver never essayed to perform a harder task and while many of them were in service until the last it was soon found that the car was too light for the work and a heavier truck of the Fiat make was utilized as they became available. All these trucks were rebuilt and equipped in France and were so satisfactory that recommendations were made that all sets, even those with brigades, be mounted in light trailers. In the Argonne the trucks could not keep up with the troops in many cases because of lack of roads or other causes and the apparatus was dismounted by the operators and carried by hand. When it is remembered that it was vacuum tube equipment with its storage batteries, weighing from 200 to 300 lbs. some idea can be had of what this meant.



The real thing—A Brigade Headquarters radio station in action. This clearly illustrated the need of a light trailer to transport the E-10 bis set

The system of radio liaison as outlined above was successfully employed by the 1st Division, when it took over the first sector held exclusively by a United States Army unit. This sector was in the St. Mihiel or Toul sector and the divisional headquarters were located at Menil-la-Tour, while Rambucourt, Beaumont and Ansanville will be remembered by many A. E. F. veterans as regimental and brigade headquarters since many divisions received their first baptism of fire in this sector. The accompanying radio liaison diagram shows the scheme of communication using T. P. S. and radio by the 1st Division in this sector.



The first radio liaison plan of the A. E. F. (that of the 1st Division) when first occupying the Toul sector

During this embryo stage of the American army's radio activity the details for the future complicated schemes of radio liaison were being worked out. The successful operation of the E-3 type undamped wave tube sets, described later, had indicated to the French the advisability of a more general use of undamped waves. They developed the E-10 types which were simpler and more compact sets than the portable and sturdy E-3 sets, but considerably less powerful. This set was a distinct achievement on the part of the French radio engineers and was the keystone to the network schemes in use at the end of the war. In these networks the ground radio liaison, 100-150 meters wavelength was allotted to trench radio and a two-way tuned, damped wave loop set was contemplated to provide and maintain trench, company headquarters, battalion headquarters and regimental headquarters communication. This loop set was to be strictly an American apparatus inasmuch as none of the Allies had a corresponding set. The only loop sets were used by the British, but they were not entirely satisfactory and were only one-way sets. A two-way loop set designed by Major E. H. Armstrong and Lieutenant Wm. H. Priess was actually constructed and successfully operated in the A. E. F. during tests before the date of the armistice. This set will be described later.

The range of 150-300 meters was allotted to regimental headquarters to communicate with adjoining regiments and with brigade headquarters. A tuned combined receiving and transmitting set was to be provided for this radio communication to take the place of the plain antenna set previously used, but due to the signing of the armistice the old French transmitting set, portable type No. 4 and the receiving set type A-1, were never replaced.

As a new departure the scope of undamped or continuous wave radio communication was extended to include brigade headquarters and the wave-length range of 600-1000 meters was allotted for brigade to division and brigade to adjoining brigade radio communication. This same wave-length range, 600-1000, was also used by Tanks to communicate with brigade or divisional commands. The set used for this service was known as Radio set E-10 bis, and was a portable transmitting and receiving set utilizing the same type vacuum tubes for both transmission and reception.

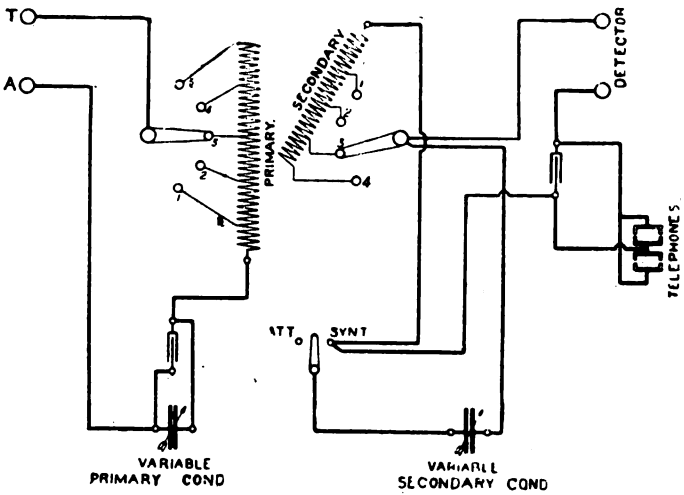
The radio liaison between division and army corps was allotted a wave-length range of 1000-1350 meters. This wave-length range was allotted to maintain radio liaison between a division and its adjoining divisions, between army corps headquarters and the army corps artillery headquarters, between army corps headquarters and the army corps air service headquarters, and between army air service headquarters and army corps air service headquarters.

The airplanes for observation and artillery fire control were allotted wave-length ranges as follows:

100-300 meters to airplanes communicating with and directing the fire of the divisional artillery. The same airplanes when operating as infantry contact airplanes communicated by radio to regimental or brigade posts of command on the same range, 100-300 meters. The set used for this service was a French wind driven generator spark set and was known as the transmitting set airplane type Y.

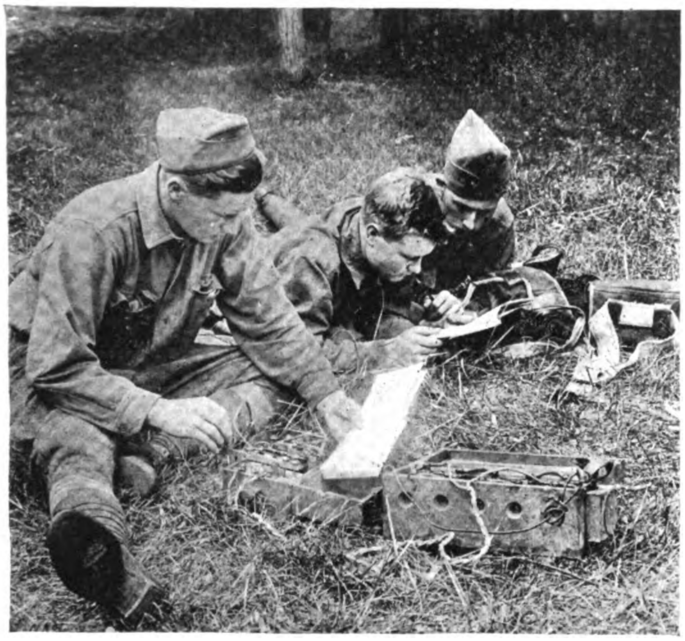
The wave-length range of 300-500 meters was allotted to airplanes communicating with and directing the fire of the army corps artillery and army artillery. The type Y airplane set was also used for this radio service.

The wave-length range of 550-750 meters was allotted to airplanes for directing and controlling the fire of long-range railway and similar artillery and radio communication was maintained by undamped or continuous wave sets for two-way communication. The airplane set was known as the E-10 airplane set and the ground apparatus was known as the E-10 artillery set. Unfortunately the transmission range of the ground set was insufficient and the airplane set was not powerful enough for consistently successful use.



Circuit Diagram Receiver of Radio Sets Type E-3 and E-3 bis

After the wave-length range assignments were made, an organization was required to enforce them. This necessitated a compilation of rules and regulations for the operation of the various stations and also a systematized organization of the radio services. The proper organization of an Army suggests that the radio stations of each unit be controlled and operated separately. This can be done by having the stations of a regiment grouped and operated on one wave-length under control by the station at regimental headquarters. A divisional net would consist of the station at the division headquarters controlling the stations at the three brigade headquarters of that division, all of them working on the same wave-length. Adjoining nets were assigned different wave-lengths to reduce interference. It will be noted, however, that most stations required two sets, as they really are in two nets, the lower unit which they command and the higher network to which they belong.



Practice Transmitting with Transmitting Set T. P. S. No. 2 bis

Each of the stations in a net was identified by means of a call composed of a letter and a figure; a letter and two figures; two letters. In certain nets these calls were changed daily according to the proposed plans. In each radio network or "net," the station which belonged to the highest military command unit was called the P. C. T. or Master Station. All of the other stations in the net were known as secondary stations and were under direct orders of the P.C.T., which controlled the traffic within the net when the net was working under control. The nets were named after the highest command to which they pertained and were: the Army Net, the Corps Net, the Division Net, the Advance Net and the Air Service Net.

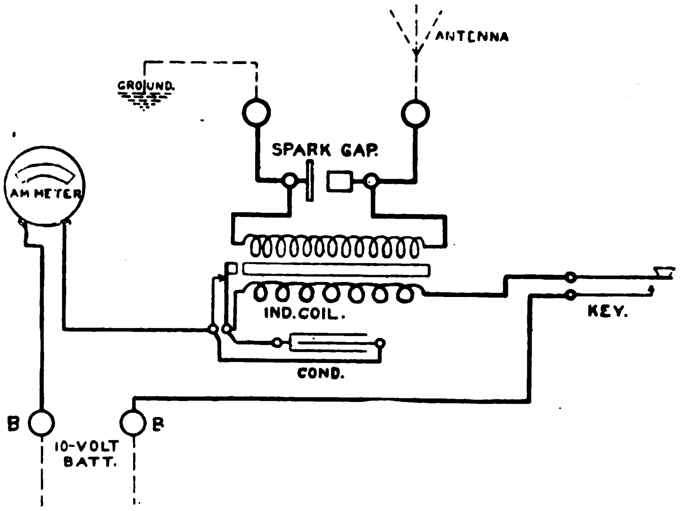
The Army Net included the stations at Army headquarters and the stations at the headquarters of each Army Corps, Army Artillery headquarters and Army Air Service headquarters. The Corps Net included the stations at Army Corps headquarters, the stations at the headquarters of the Divisions comprising the Army Corps and the Army Corps Air Service Group. The Division Net included the Divisional headquarters station and the stations at the headquarters of the Brigades of that Division, the Advance Center of Information and the Artillery Brigade headquarters of the Division. The Advanced Net included the Brigade headquarters station and the Regimental headquarters comprising the Brigade.

The exact wave-length, selected from the allotted wave-length range, to be used during operation in each net was fixed by the Radio Officer of the Army in which the net operated. This regulation of net operation was effected by means of radio liaison plans which were issued from time to time. When a net was operating, all of the stations in the net were listening. This necessitated that each station be sharply tuned to the prescribed wave-length and that the operator of each station have his head phones on and be following the traffic in the net. At no time was any station without an operator on duty, after the station had once reported into the net.

A net was operated either as a "free net" or as a "controlled net." When operating as a "free net" the P. C. T. or control station never interfered, but listened in to see that the secondary stations observed the operating rules. A station having a message to send called the addressed station after having previously listened in to guard against interference. In case there was disorder in the net the P. C. T. usually assumed control of the net by sending the conventional R. D. followed by the P. C. T. call, making it necessary for a secondary station to obtain permission from the P. C. T. before calling another station in the net. The P. C. T. sent the signal R. L. when the net was released from control and the net then became free.

The Network Charts and Wave-length Schedule accompanying this article will give some idea of the complexity of the network systems and the plans for the employment of radio-telegraphy will show what an undertaking it was to assign wave-lengths and call letters to all of the stations in the various networks, if interference was to be reduced to a minimum.

The assignment of equipment to stations can be noted on the network chart. It is described in detail and illustrated by the accompanying photographs and circuit diagrams.



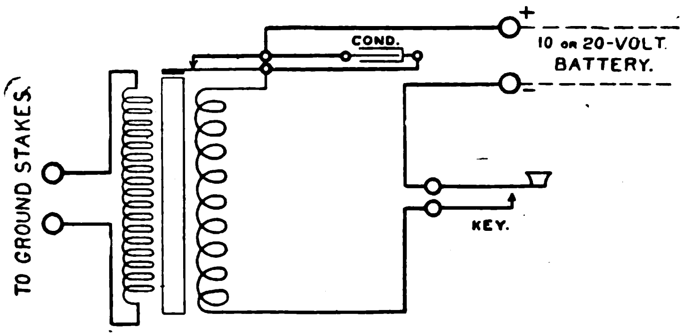
Circuit diagram of Transmitting Set Portable Type No. 4

The list of standard French radio equipment was as follows:

- Ground Telegraphy
  - Transmitting Set T. P. S. No. 2 bis
  - Receiving Set T. P. S.
- Radio Telegraphy
  - Transmitting Set Portable Type No. 4
  - Receiving Set Artillery Type A-1
  - Amplifier—Type 3 ter
  - Radio Set, Type E-10 bis
  - Radio Set Type E-10 Artillery
  - Radio Set Type E-3 bis
  - Radio Set Type E-3 ter.

The Transmitting Set T. P. S. No. 2-bis, consists of a high power buzzer operated by a 10-volt storage battery with its secondary, as shown in the diagram, connected into a line of well insulated field wire whose ends for efficient operation were grounded by means of metal stakes at points varying from 150 to 300 feet apart. The interrupter of the buzzer carried a slidable weight which could be used to vary the frequency of vibration from about 300 to 750 per second providing a distinctive note. Naturally no tuning was involved in the receiving.

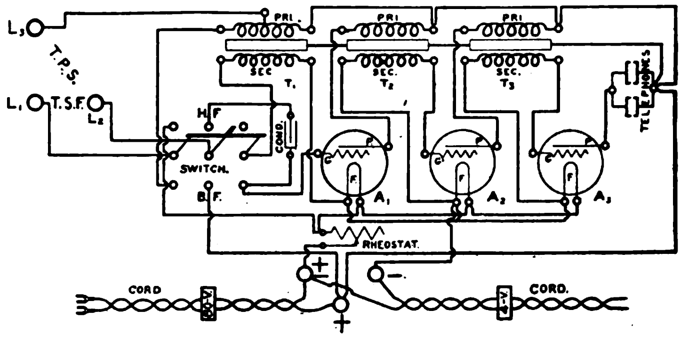
The key was inserted in the primary circuit of the buzzer whereby it was possible to send pulses of alternating current into the ground where they spread out and set up currents in a similarly grounded line at the receiving station. Telegraphic signals were thus transmitted from one station to another. The maximum normal distance of reliable transmission by T. P. S. was about 2,000 yards. The receiving set T. P. S. comprised a low frequency three-step vacuum tube amplifier, whose circuits are shown in the diagram herewith, connected by insulated wire to a pair of ground stakes in the same manner as the transmitter. Inasmuch as audio frequency currents are set up by the transmitter no detecting action is necessary at the receiver. For best results the two base lines, or the line of ground stakes, of the transmitter and receiver should be parallel or approximately so, and laid out with the aid of a compass.



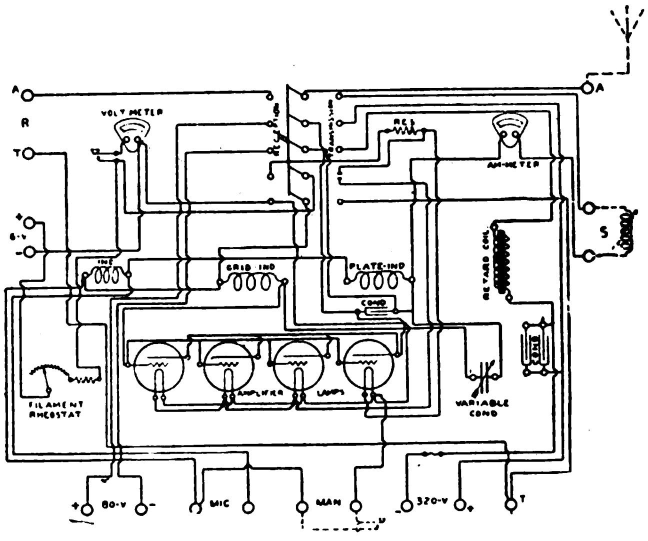
Circuit diagram of Transmitting Set T. P. S. No 2-bis

Receiving with Receiver Type A-1 and Amplifier Type 3 ter

The American equivalents of the French T. P. S. transmitter and receiver are known as S. C. R.-71 and S. C. R.-72 respectively. The two-way American S. C. R.-76 T. P. S. set was a combination of the two above types, which eventually would have replaced the French equipment, but it was never available in quantities for distribution to American Signal troops. It was considered superior electrically and mechanically to the French equipment.



Circuit diagram of Amplifier Type 3-ter

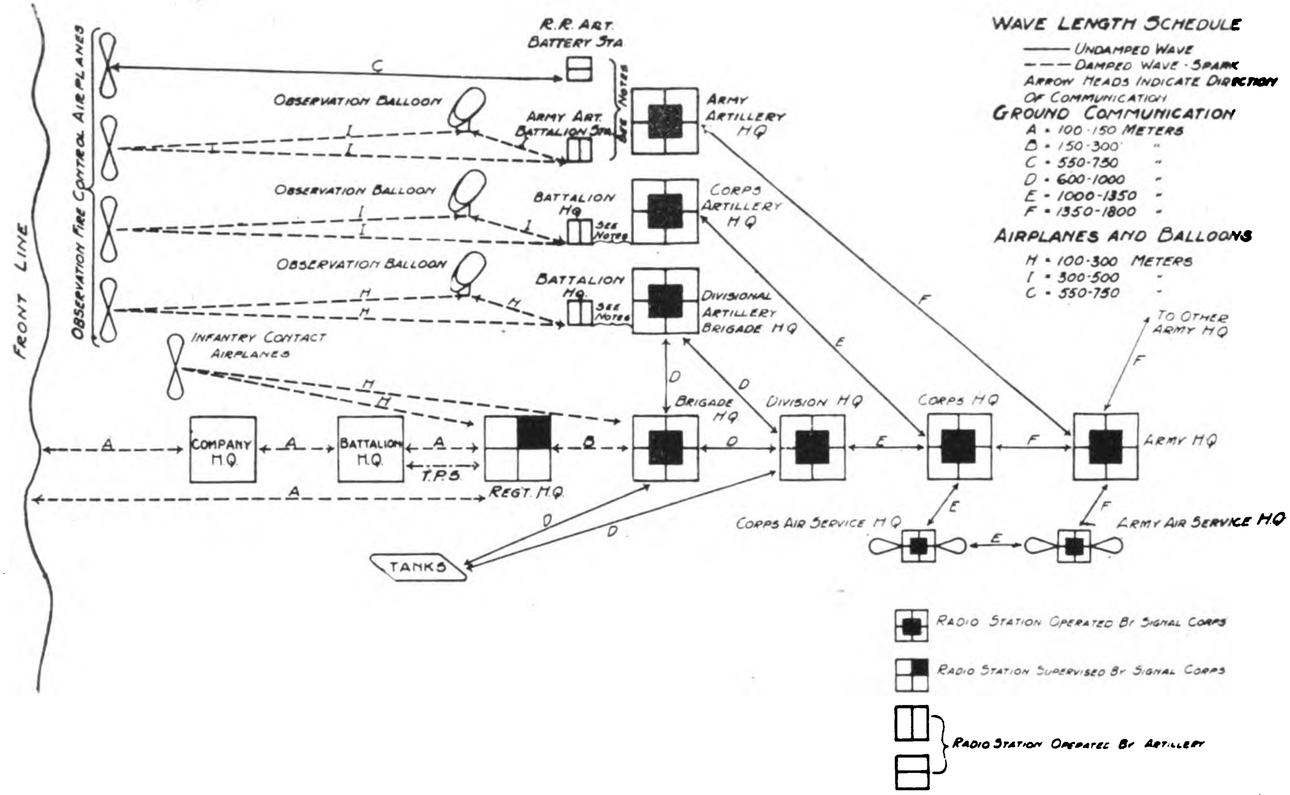


Circuit diagram of transmitter and heterodyne for Radio Sets Type E-3, E-3 bis and E-3 ter

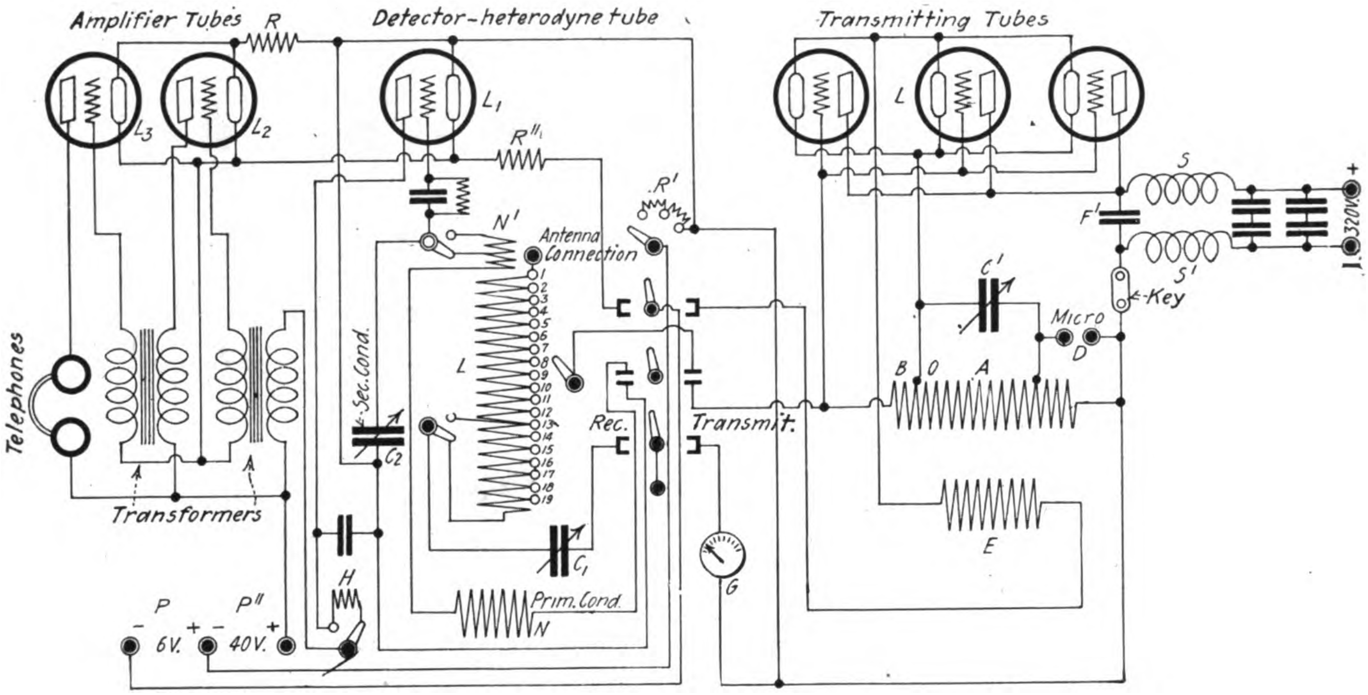
The amplifier type 3 Ter.—a very useful piece of apparatus—was an integral part of any sets, such as, the receiving set T. P. S. and the E-3, E-3 bis. and E-3 Ter. sets. It was also a useful adjunct, as in connection with the receiving set type A-1. The amplifier 3-Ter. comprised three standard French vacuum tubes coupled by means of transformers—shown in the diagram—and supplied with current by storage batteries giving 4 volts for the filaments and 40 volts between plates and filaments. A rheostat in the filament circuit was the only means provided for varying the degree of amplification. Two leads were provided and a triple-pole double-throw switch for changing from connections whereby the amplifier acted as a low frequency amplifier for T. P. S. reception or for use as an amplifier, in conjunction with a crystal detector, to connections whereby the instrument might be used as a simultaneous detector and amplifier of radio signals. In this latter case the first of the three vacuum tubes acted as a detector and the other two as low frequency amplifiers. As soon as the availability of this amplifier became known to our operators, they immediately failed to get any results with their crystal detectors. Artillery operators complained that every time a battery fired the sensitive points on the crystals were lost and other stations complained that every time a shell exploded they were in the same predicament, no matter how far they might be from the disturbance. It was decided to restrict the use of the amplifier to simplify the storage battery supply which was required with them, but in the end nearly every spark station had an amplifier and it must be admitted that the operators were probably justified in their attitude. Future practice of the Signal Corps will probably provide valve detectors and amplifiers with all spark receivers. As stated above the S. C. R.-72 was the American equivalent of this amplifier, except that it did not operate as a detector.

The receiving set artillery type A-1 was probably the most widely used piece of radio apparatus in the A. E. F. It was a simple form of receiver for damped waves, using crystal detector or the above amplifier with a wave-length range of 100 to 550 meters. It was practically fool proof, extremely simple to manipulate and available in large quantities. The receiver of this set comprised a box containing a primary and secondary circuit, as shown in the wiring diagram, each made up of a variable air condenser and an inductance. The primary coil was provided with four taps and the

RADIO WAVE LENGTH SCHEDULE



Receiving practice with an American made SCR 54 Receiver and a French Amplifier Type 3 ter secondary coil with five taps connected to the contacts of corresponding dial switches. The terminals of the primary circuit were connected to the ground and antenna respectively. Across the terminals of the secondary coil was connected the detector circuit which consisted of a galena crystal detector and a pair of telephone jacks, shunted by a small condenser. The secondary condenser was arranged to be cut out of the circuit by means of a switch, thereby making the secondary circuit a periodic for receiving signals of unknown wave-lengths. The receiving set Artillery type A-1 was complete with sectional bamboo antenna poles for the erection of a V type antenna.



Circuit diagram of Radio Set Type E-10 bis

The transmitting set portable type No. 4 which has been mentioned above consists of an induction coil, as shown in the accompanying diagram, operated by a 10-volt storage battery which supplied about 3 amperes to the primary for efficient operation.

The spark gap in the secondary circuit of the coil is connected to the ground and antenna circuits directly. The antenna for use in the trenches consists of a single wire from 75 to 100 feet long stretched between two supports about 4 feet above ground. The interrupter should make about 100 vibrations per second. There is no provision for tuning and the wave-lengths emitted depend upon the length and height of the antenna. The radius of transmission was normally about 2½ miles under favorable conditions.

This set made many an American operator, who had long known this type of set as an amateur, decidedly homesick at first and then decidedly doubtful as to its utility in war. However, it had been adopted because of its simplicity and, with a slightly higher antenna which was possible at regimental stations, it could be relied upon for transmission over 5 or 6 miles. Its defects soon became evident and efforts were immediately started in the Radio Division to obtain better equipment for the front lines as the necessity for more reliable communication and sharper tuning became necessary.

The best undamped wave communication was probably obtained by means of the radio set E-10 bis, for the reason that it was the most compact and rugged of all the undamped wave standard French radio apparatus utilized by American signal troops. It is true that it had its disadvantages, but it can be said that it certainly was the most popular piece of undamped wave radio apparatus in the A. E. F. The E-10 bis set was designed to transmit undamped wave signals and receive either damped or undamped wave signals. Six standard French vacuum tubes were used, three for transmitting and three for receiving. In transmitting, oscillations are generated by three vacuum tubes operating in parallel as shown in the accompanying diagram, a potential of 200-320 volts being applied to the plate-filament circuit and 6 volts to the filaments. When connected to a horizontal V-shaped antenna, 29 meters on a side and supported 4 meters above the ground on bamboo poles, the set will transmit on wave-lengths ranging between 600 and 1,000 meters. For wave-lengths between 600 and 800 meters the lead from the apparatus to the point of the V should be 10 meters long; for longer waves it should be 12-15 meters long. This set could also be used with a single wire antenna 40 meters long including the lead to the set and supported 1 meter above the ground.

When used with the antenna described, a good ground and with 300-320 volts on the plates, the input into the antenna should be about 0.5 ampere for the short waves and 0.6 amperes for the longer waves. Under favorable conditions the efficient range between two sets was usually from 50 to 60 kilometers. The plate voltage for undamped wave transmission in general was supplied either by eight 40-volt storage batteries or by the American made 12-320 volt Westinghouse dynamotor which was furnished from the United States during the latter part of the war. Though only available in limited quantities, eventually all sets would have been provided with this efficient source of plate potential.

For receiving radio signals, damped or undamped, the E-10 bis set was provided with three vacuum tubes, as above described. When undamped signals were to be received one of the tubes acted as a detector and heterodyne, while the remaining two tubes amplified the detected low frequency signal impulses. The same 6-volt filament storage battery was used for both transmitting and receiving. The plate potential for the receiving tubes was furnished by a 40-volt storage battery. This storage battery should not be one of the series of 8-40 volt plate batteries used for transmitting.

An interesting piece of radio equipment which accompanied the E-10 bis sets was the wavemeter type T-1 which comprised a variometer and a fixed condenser, forming an oscillatory circuit, as against the fixed inductance and variable condenser commonly used. A small incandescent lamp was connected in circuit, as shown in the diagram, and was heated to a dull redness by a dry cell. The lamp served to indicate the resonance point when the transmitter was adjusted to the proper wave-length. A small buzzer in the wavemeter box may be used when it is desired to calibrate receiving circuits.

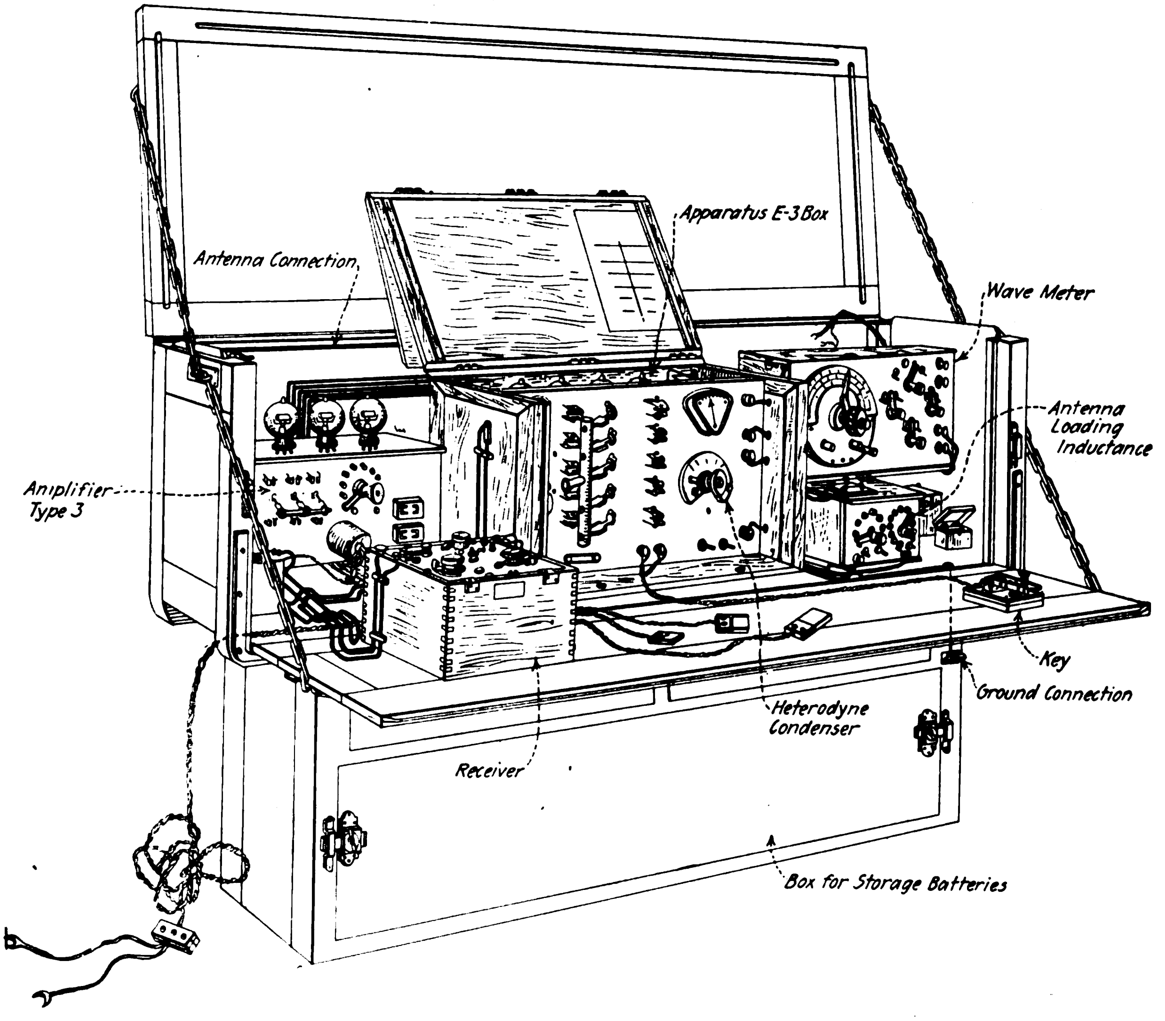
An American equivalent of the E-10 bis set was being developed in the United States at the termination of the war, but none were ever available to the A. E. F.

The series of E-3 sets—the radio sets E-3, E-3 bis and E-3 Ter—were practically identical in so far as design is concerned and the accompanying sketch may be considered as representative of this series of sets. The E-3 set became obsolete because its wave-length range 600-1,000 meters was assigned to the E-10 bis sets described above. The E-3 bis had a wave-length range of 1,000-1,350 meters and the E-3 Ter a range of 1,350-1,800 meters.

The accompanying schematic and circuit diagrams show the main features of these sets. Both the E-3 bis and E-3 Ter sets transmitted undamped wave signals and the continuous oscillations therefor were set up by four standard French vacuum tubes operating in parallel. Six volts is provided for the filament and 320 volts for the plate potential. These sets put about 6 to 8 amperes into the V-shaped antenna, 50 meters on a side with a 60° central angle and about 5 meters off the ground.

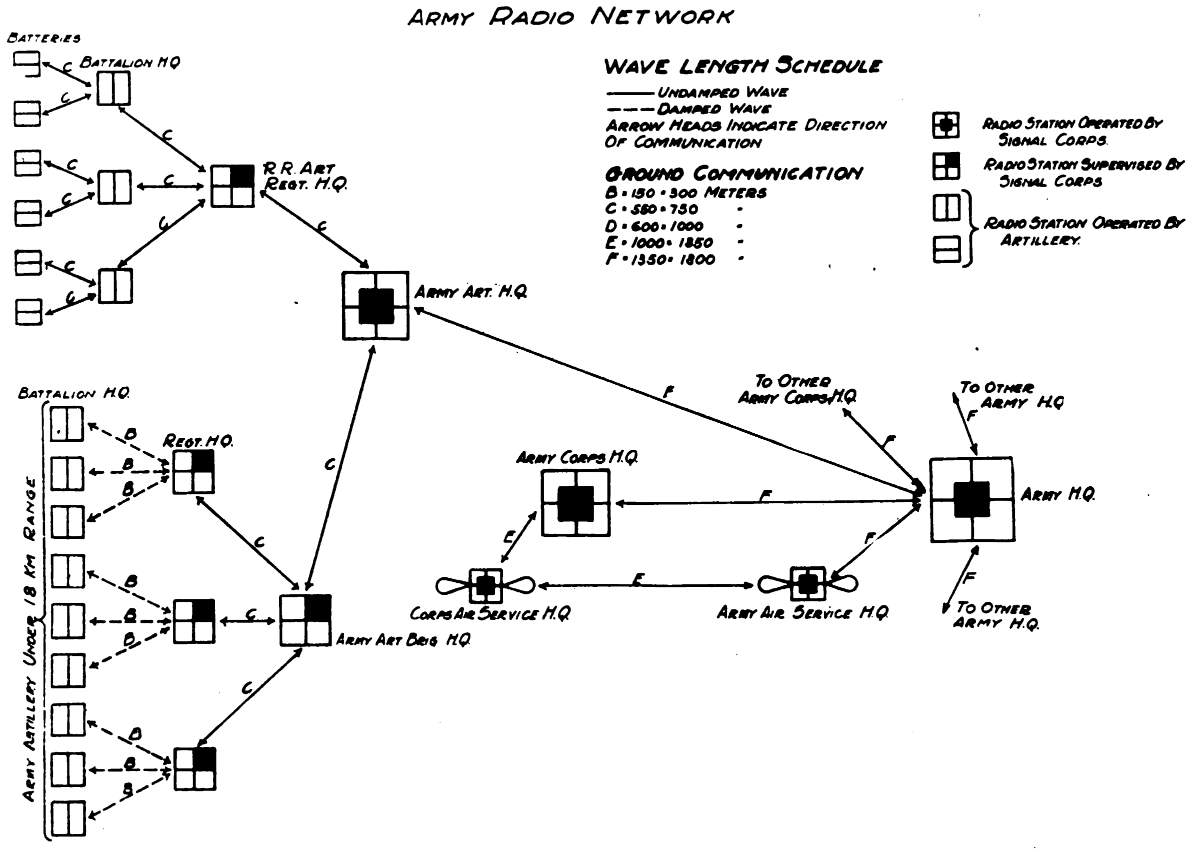
The E-3 bis and E-3 Ter sets were adapted to receive damped and undamped signals of a range of wave-lengths somewhat greater than that for transmission. The transmitting box circuit with one vacuum tube oscillating is used for the purpose of a separate heterodyne and the amplifier 3 Ter, as the detector and amplifier. The usual practice was to use 40 volts as the plate potential of the heterodyne tube.

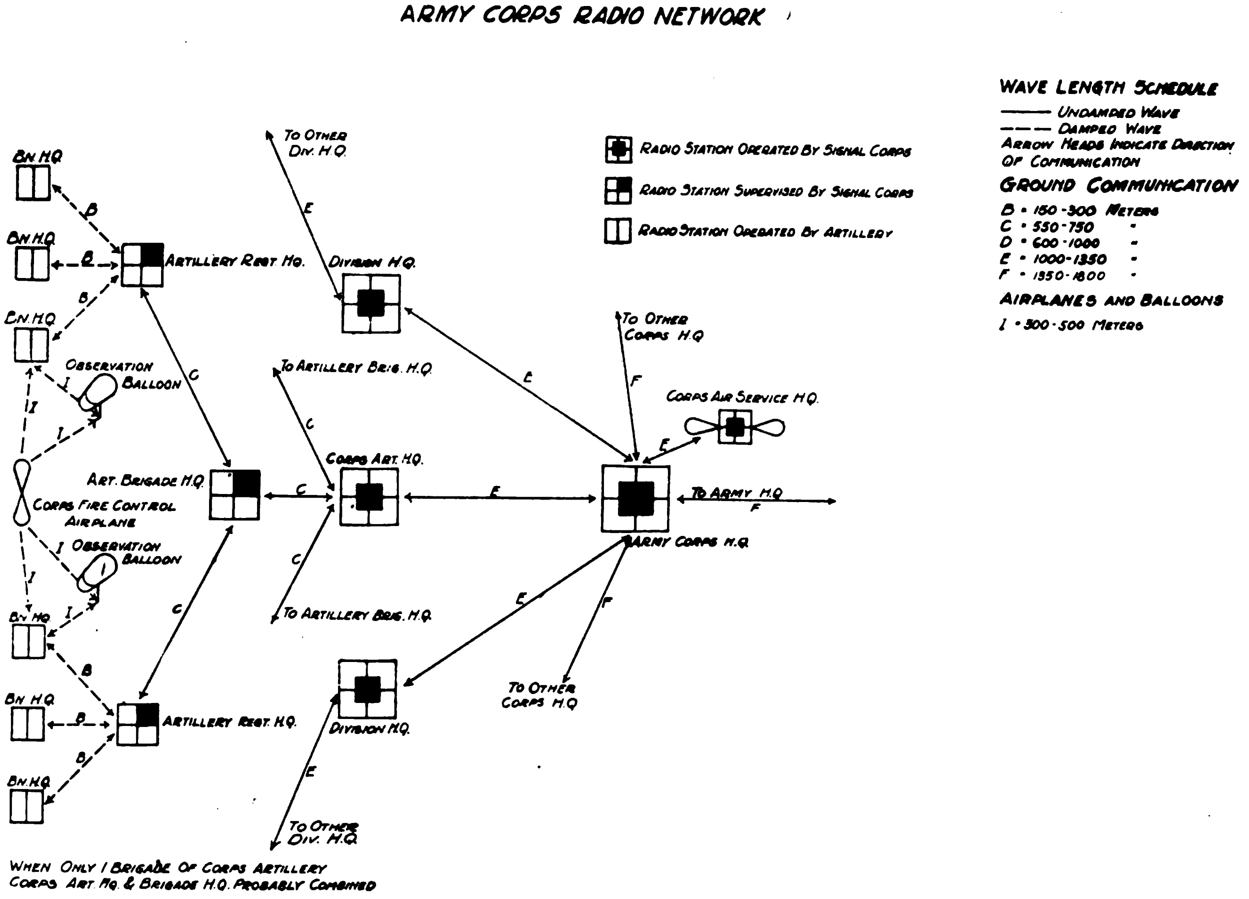
Shortly before the signing of the armistice a new set was developed by the French known as radio set type E-13. This set was found to be very efficient in operation and was extremely compact, as compared to the bulky E-3 bis or E-3 Ter sets. The wave-length range was from 1,200-2,800 meters. It was



Sketch showing method of mounting the various component parts of Radio Sets Types E-3, E-3 bis and E-3 ter

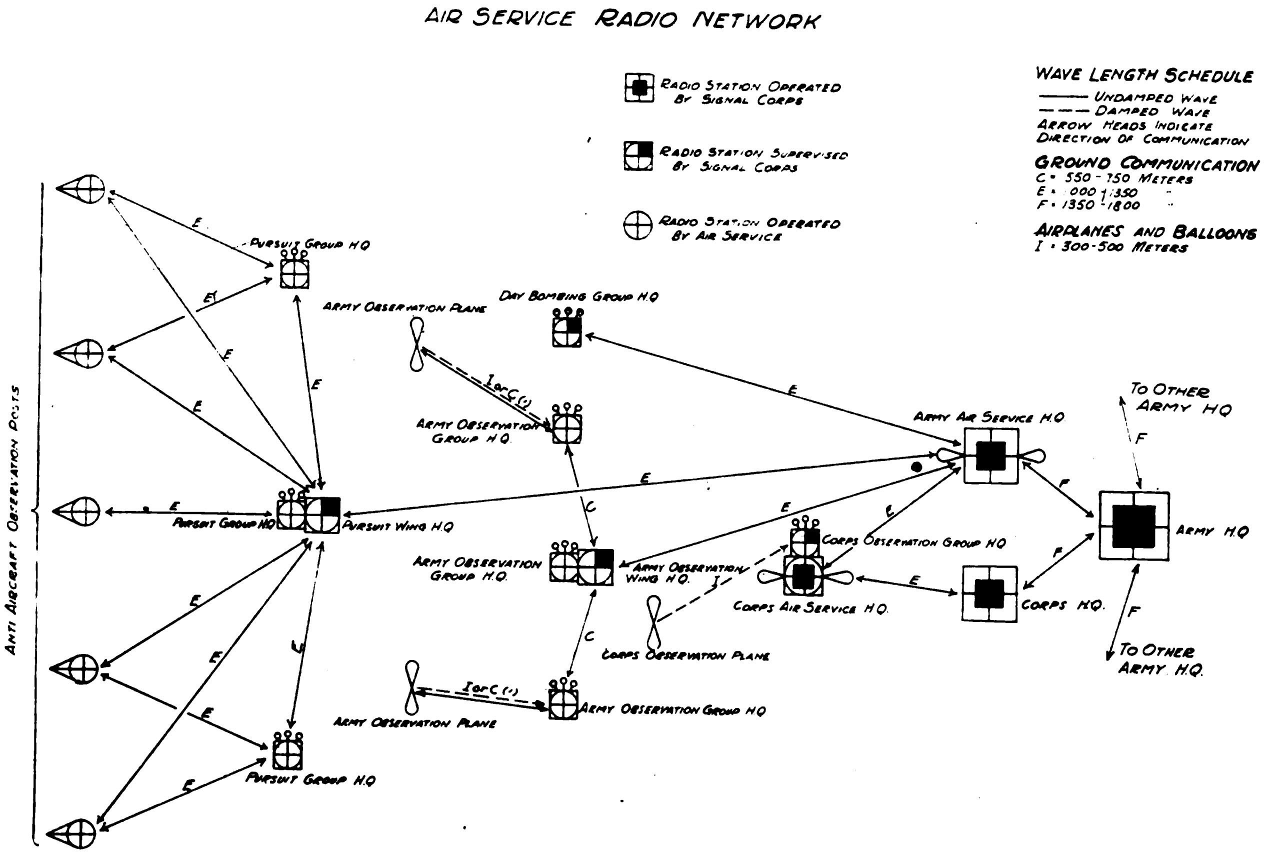
planned to reduce the lower figure to 1,000 meters in order that it might be used as a set to replace both the E-3 bis and E-3 Ter sets. The accompanying schematic diagrams show the circuit arrangements of this set.

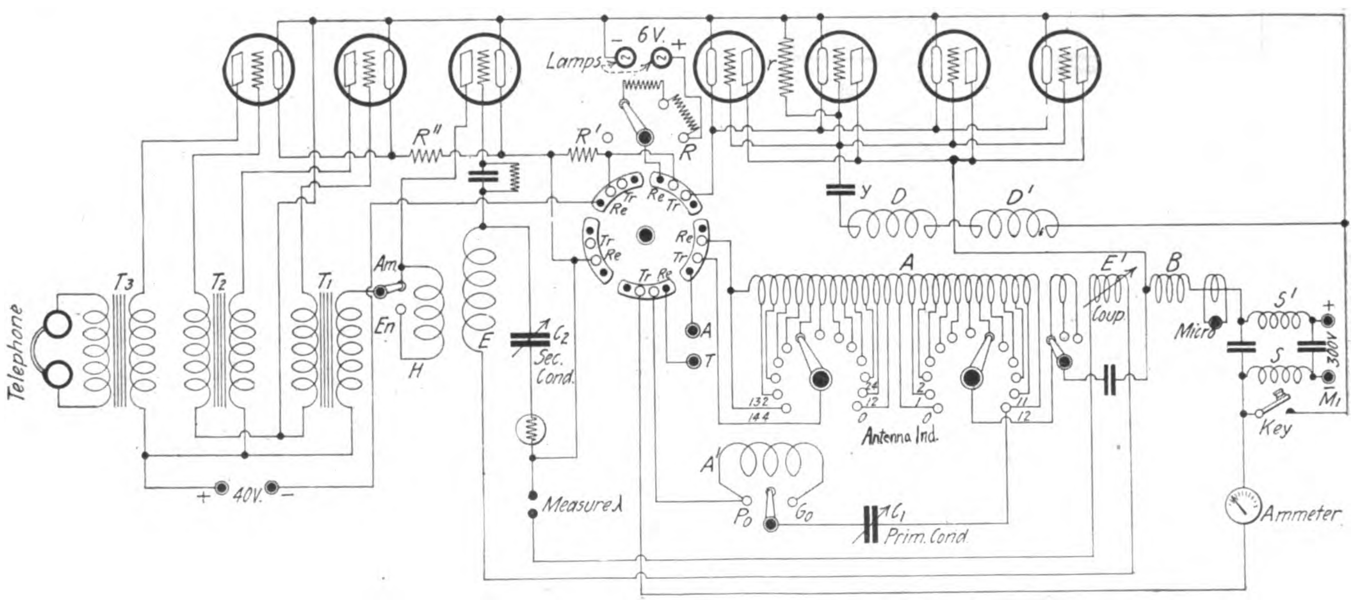

ARMY RADIO NETWORK


ARMY CORPS RADIO NETWORK

When only 1 Brigade of Corps Artillery Corps Art. Hq. & Brigade H.Q. probably combined

For transmission four standard French vacuum tubes operating in parallel generate the undamped oscillations. It will be noted that the grid is coupled to the plate and also to the antenna loading inductance. The maximum efficiency in the transfer of energy to the antenna is obtained by means of the arrangement of the antenna loading inductance A and a coil B in the plate circuit wound on the same ebonite tube. The





Circuit diagram of Radio Set Type E-13

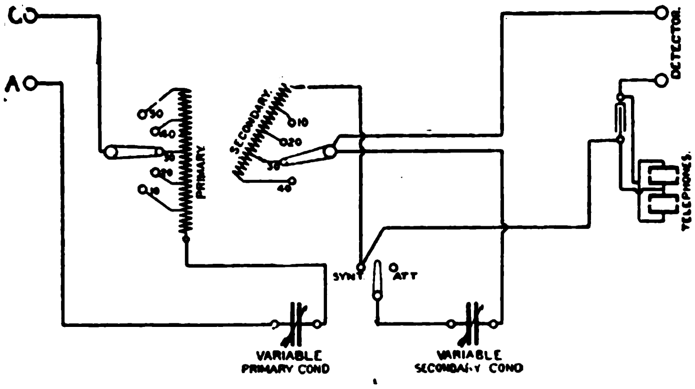
two grid coils D' and D are in series and link with the coils A and B respectively. The coil D' is placed within the coil A giving a close coupling and the coil D is outside and adjacent to the coil B being thereby loosely coupled to it. It is obvious that when the inductance in the antenna is increased the coupling between the coils D and A is increased. This arrangement makes possible a favorable value of coupling for all wave-lengths within the range of this set.

The coils S, S^1 and the condenser M^1 serve to smooth out current variations when a dynamotor is used to provide the 320 volts for the plate potential. The condenser N in the antenna circuit prevents the plate current from flowing in the antenna circuit.

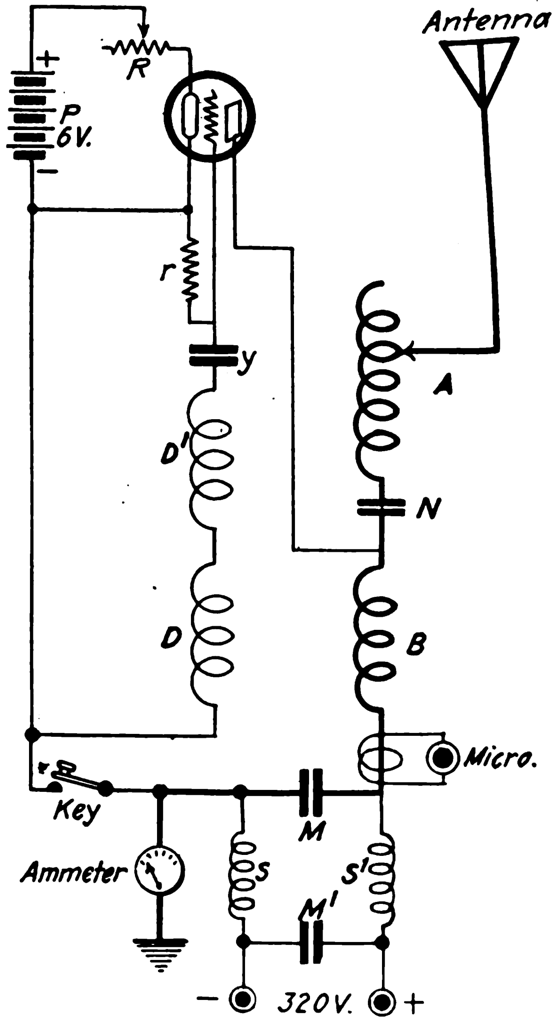
A key in the plate circuit is used for telegraph signals and an auxiliary coil wound around the coil B and in series with a microphone permits the set to be used for radio-telephony, in which case the key is short circuited. For reception three standard French vacuum tubes are used for receiving either damped or undamped waves. When receiving damped wave signals, one of the tubes acts as a detector and the other two

Transmitting practice with Transmitting Set Portable Type No. 4

become low frequency amplifiers. It will be noted that the receiver secondary circuit comprises the variable condenser C-2 and two fixed inductances E and E. The inductance E is not coupled to the antenna circuit but it is mounted, together with the inductance A of the antenna, in the form of a variometer. Tuning of the antenna circuit is accomplished by means of the condenser C and by the inductance A¹ in series with the inductance A. The coil A¹ may be entirely or partly used, or cut out of the circuit. When receiving undamped or continuous waves the coil H coupled to the coil E serves to maintain the local oscillations by the tube L for heterodyne reception. The coil H may be cut out of the circuit when damped waves are received. The tubes L-2 and L-3 comprise a low frequency amplifier and they are coupled by the transformers T-1 and T-2. The telephones are coupled to the plate circuit of the tube L-3 through the transformer T-3. The commutation switch provides for rapid changeover from receiving to transmitting.



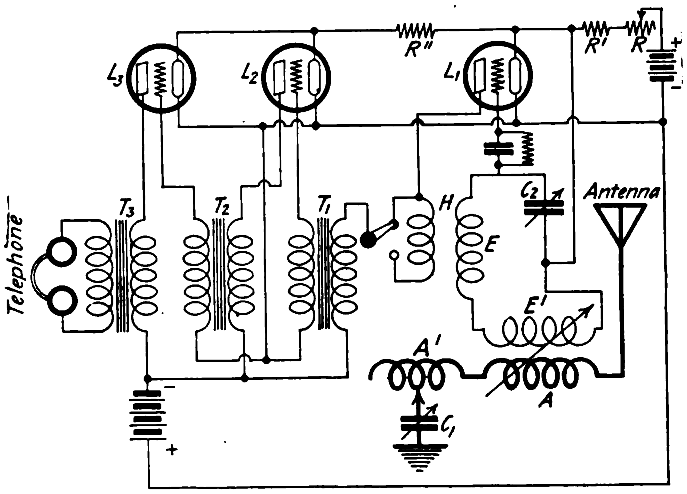
Circuit diagram of Receiver Type A-1



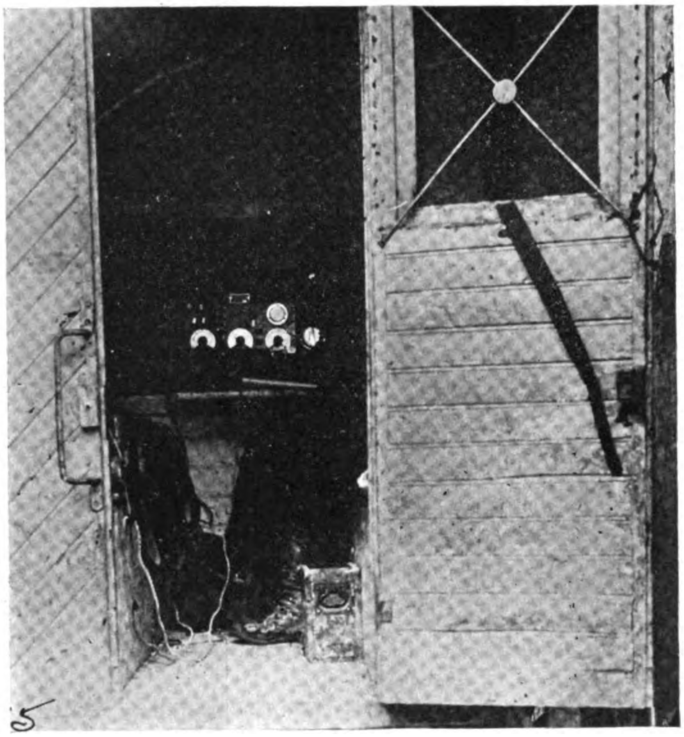
Simplified diagram of Radio Set Type E-13 transmitting tube circuit

It will be noted by reference to the circuit diagrams of the French undamped wave vacuum tube sets, that provision was made for radio-telephony, the sets being fairly efficient though never so used in the armies. We have already indicated the difficulty in suppressing indiscreet language over wired telephone circuits where theoretically, at least, they could be made secret. It need not be explained what would have resulted if radio-telephony had been utilized to intercept stations the Germans were operating against us. The

A Ford Radio Tractor, Divisional Headquarters Radio slang phrase "I'll tell the World" would have had a real meaning in that case.



Simplified diagram of Radio Set Type E-13 receiving tube circuits



View showing interior of Fiat Tractor in which was mounted both an E-3 bis Set and an E-10 bis Set. The E-10 bis equipment can be seen through the open door

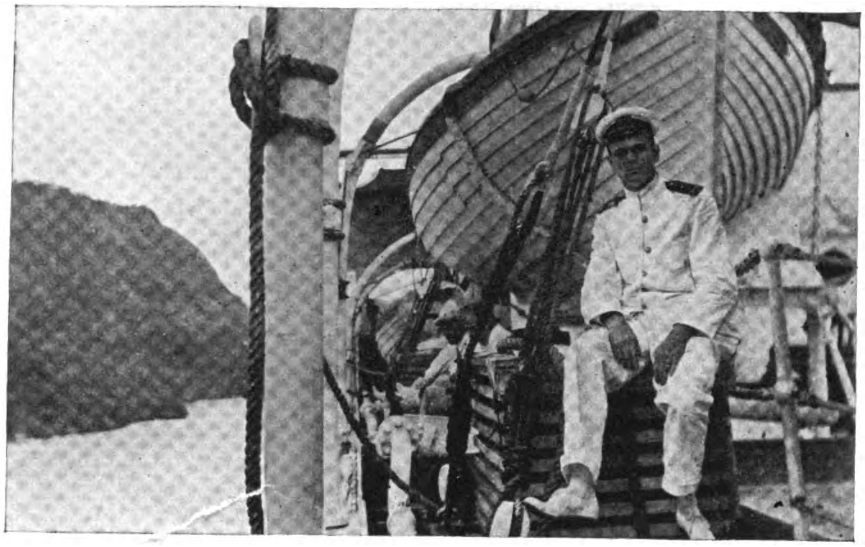
This article outlines in a technical way the offensive or communication radio service in our army. It does not picture the problem of the individual stations or their operators, who by their efforts made their particular station efficient and reliable and thus contributed to the successful entity. Imagine yourself the operator of a regimental or brigade headquarters station located in a muddy dugout, with a gas curtain over your dugout entrance and you with a gas mask on trying to get a message through, hoping the next shell doesn't take away your antenna, or that you are the operator of a station in an abandoned French home in a tiny village, or in the kitchen of an old stone house which could not have been very comfortable at its best, but now damp, cold and bare of everything that suggests a human habitation, is your combined workshop and habitation. If it is winter it is cold and clammy and you yourself are covered with the grey mud of northern France. This is not a very encouraging condition under which to operate your station, but it may at any moment become the only means of communication and you are always one of the important links that make the various networks outlined above effective. You are left mainly on your own responsibility, your personal trials and tribulations would make interesting reading, but unfortunately they could not be recorded in this article.

Radio Restrictions Removed

It is announced by the Navy Department that restrictions on amateur, technical and training schools and experimental stations are removed on

October 1st

Applications for transmitting licenses will be received by mail only at the local offices of the Radio Inspector, Department of Commerce.



A radio operator has ample opportunity to observe many things of more than passing interest, and with duties that are far from confining there are many chances to get the passenger's viewpoint on these same affairs

On the next trip we were yet far from the wharf when Snell and I made out two forms, so wildly gesticulating from the tops of two posts that both the captain and the mate trained their glasses on the figures, thinking that something was wrong with the ship. As we drew nearer we recognized out two college friends, tanned dark as Indians, one of the effects of loafing "something terrible," Bunny explained.

I thought of her sister ship, the Northland, driving through the heavy swells off the coast

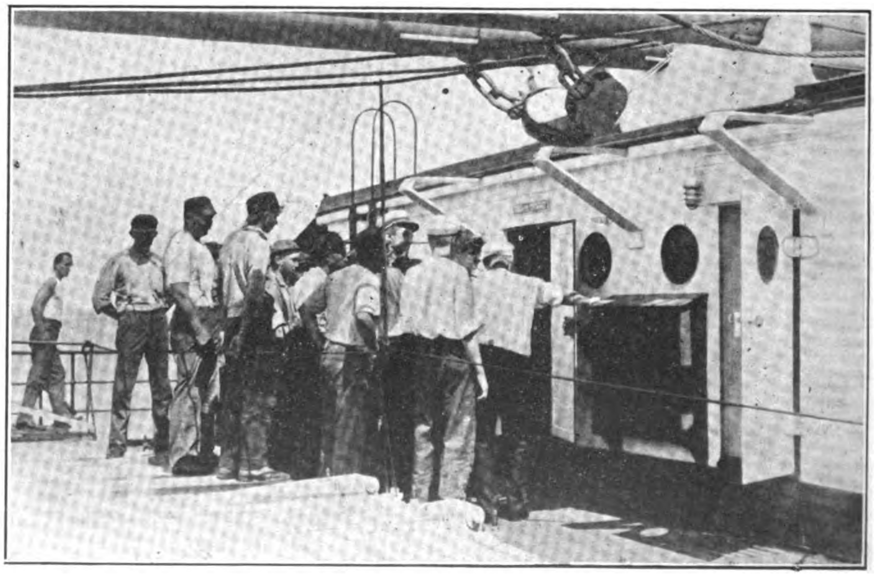
Quite grandly we were escorted to a waiting machine, a monster brought down from Calumet for the special use of the convalescent and his nurse. Quite slowly, we started up the long hill to town, but once out of sight of the dock the speedometer took a jump. "We discovered yesterday," Skeet announced, "that she'll do sixty-three. Not bad for an old tub like this, eh?"

I agreed that it was pretty good as I jammed my uniform cap tightly over my ears. Bunny was driving, and telling Snell about six or seven dances which he had attended the last week. "But I thought uncle said you went to bed at eight o'clock," my partner remarked.

"Oh, we do," asserted Skeet. "So does uncle. He sleeps soundly, too, and our window is not very far from the ground."

After the invalid had taken us, at breath-taking speed, out past the School of Mines and had shown us facilities they used at the club house, the swimming and tennis—unknown to Uncle—we returned to town. Suddenly Skeet sat bolt upright, thumped Bunny on the back and pointed up the street: Uncle Douglas coming toward us in earnest conversation with another man. Instantly, the car slowed down to a mere walking pace, and our two friends put on their long and tired countenances.

After a short conversation relating mainly to hopes of getting well, and not overtaxing their strength, Mr. Douglas moved on. Slowly the car moved off, until the old gentleman had turned a corner, when the former speed was resumed.



The warning blast sounded—Mates, steward and cooks hastened aboard

A mile or so beyond the town limits we came upon a copper mine. The huge piles of slag and of copper ore were of absorbing interest when we had been initiated into the mysteries of smelting copper ore. At one place we saw trainloads of logs waiting to be thrown into the molten copper to burn out the oxygen. We learned that in a shaft farther up the hill five men had been working for several years, trying to get deep enough to reach a vein that ran at an angle to the surface. Not until this vein should be struck would the remainder of the mine be constructed. The blast furnaces and the various stages of the refining process before the copper ingots were formed in their moulds provided an entertaining hour's trip through the works of the mine. It was rather surprising to see our restless companions at all composed in the presence of such mundane surroundings.

Two hours later we went back to the steamer and said a reluctant farewell to our new-found hosts. I assure you not a thought was given to the "monotony" which some people think is the wireless operator's portion.

Some Modern Vacuum Tube Circuits and Their Operation

By J. Scott-Taggart

In view of the innumerable circuits which have been devised from time to time, many of which are due to American research workers, the ones which follow can lay no claim to originality. They are the outcome of practical work based on the fundamental circuits evolved by such eminent scientists as E. H. Armstrong, H. J. Round, Lee DeForest, and others. From the point of view of practical utility, economy, and facility of construction and operation, as well as efficiency, the circuits given here may be of interest.

A "Stand-by" and "Tuned" Continuous-Wave Receiver

The reception of continuous waves is accompanied in many cases by equally strong signals from stations transmitting with damped waves. Perhaps the simplest method of lessening this interference is to use a very loose coupling between an aerial circuit and a closed oscillatory circuit slightly mistuned. The distance between the circuits may be in the neighborhood of three feet, in which case the spark interference is almost altogether eliminated. The strength of the continuous wave signals is, of course, lessened at the same time, but not to the same extent.

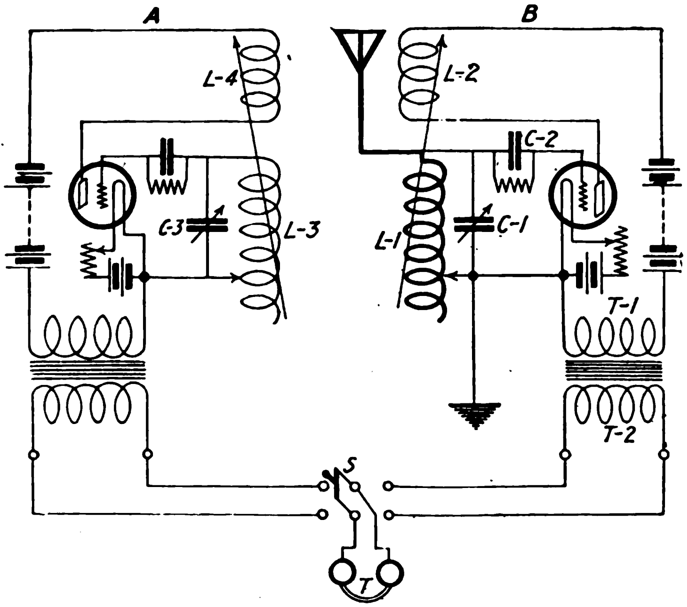


Figure 1—Circuit diagram of the "stand-by" and "tuned" continuous-wave receiver

Many interesting conclusions may be drawn by constructing two circuits A and B separated by a distance of about one foot. The circuit B is an ordinary simple regenerative receiving circuit, which by tightening the coupling between the aperiodic coil L-2 and the inductance L-1, may be set into self-oscillation at a frequency mainly determined by the position of the variable tapping from L-1 and the value of the condenser C-1. The plate oscillatory circuit consists of an aperiodic coil whose natural wave-length should be less than that of the smallest wave-length to be received on the circuit. Detector action is obtained by means of a condenser C-3 shunted by a resistance of about 2 megohms. This resistance may conveniently consist of several scratches on a piece of rough ebonite filled with graphite by rubbing an ordinary lead pencil across the grooves until a resistance tester connected across the terminals indicates the correct resistance. Instead of a pair of high-resistance telephones in the plate circuit, a step-down telephone transformer T-1, T-2 may be used, the high resistance winding of which may have a value of, say, 10,000 ohms. The low resistance winding T-2 should have a resistance equal to that of the 'phones (usually about 120 ohms). It should be of heavier wire than the winding T-1 which latter may conveniently have about 5 times as many turns as T-2. The switch S when swung over to the right brings the telephones T into the B circuit.

The circuit A is a somewhat similar one except that no aerial or earth connections are made to it. The coupling between L-4 and L-3 is variable and the vacuum tube is used to rectify as well as to produce regenerative action or self-oscillation. By swinging the change-over switch S to the left, the telephones are connected in the A circuit.

When the 'phones are connected in the B circuit, the latter of itself is capable of receiving continuous waves. The coupling between L-2 and L-1 is tightened until a rustling sound is heard in T. The vacuum tube is now generating oscillations. On touching the aerial, a sharp click will be heard in T; if L-1 is variable in steps by means of studs and a radial switch, on moving the switch across the studs clicks should be heard; the same result is obtained when C-2 is shorted, as it usually can be, by turning it to zero or maximum reading. Since these effects are not produced when the vacuum tubes are not oscillating, they may be used as an indication. The best indication, however, is the reception of continuous waves.

When receiving continuous waves, the circuit B is made to oscillate at a frequency slightly different to that of the incoming waves by a suitable adjustment of L-1 and C-1. The beats produced will be rectified by the tube and will give signals in T. This circuit has at least two disadvantages. The first is that the strength of the local oscillations in B is not smoothly variable; for maximum strength of signals it should be, as has been pointed out by Armstrong. A certain amplitude (greater than that of the incoming waves) gives the best results. The second, and very important disadvantage, is that since we have mistuned our local circuit, the aerial circuit will be slightly out of tune with the incoming waves. This results in a weakening of the incoming oscillations which, however, retain their frequency and force themselves into

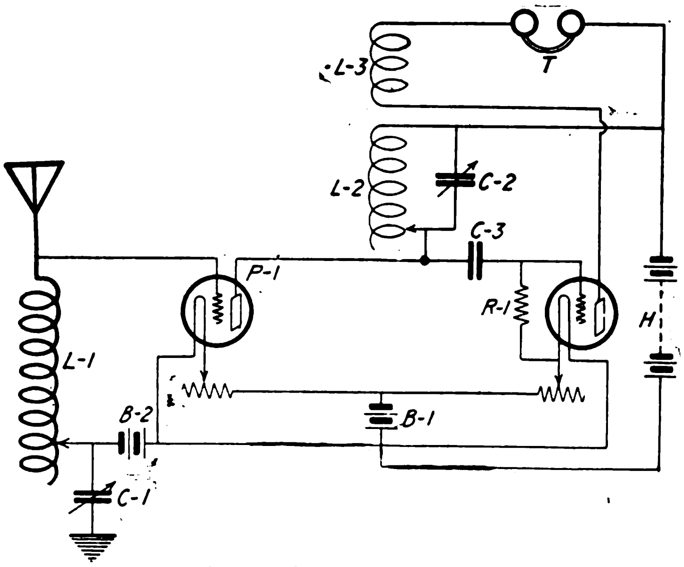


Figure 2—Diagram of connections of the general receiving circuit for damped or undamped waves

the circuit. The higher the beat note received, the greater will have been the mistuning of the aerial circuit and consequently the greater the opposition to incoming waves. This effect lessens the strength of weak signals considerably and explains why the lower beat notes are the loudest on this type of circuit, whereas the most pleasing frequency is about 1,000 per second. When the aerial circuit is perfectly in tune with the incoming signals the local oscillations will have the same frequency as the incoming ones and no beats are produced. If the local circuit be tuned to either side of this silent interval, beats will begin again and a note will be heard in T. Thus by adjustment of the condenser C-2 until no beats occur, we have a very accurate method of tuning our circuit to the wave-length of the incoming signal.

Continuous wave signals are very easily picked up on this circuit which is, therefore, convenient for use when "standing-by" or when searching. Once the station has been picked up, we may eliminate interference by using the "tuned" circuit brought into operation by moving S to the left. The circuit B is first adjusted for no beats with the incoming signal. The filament current (or plate voltage) is then decreased until the vacuum tube ceases to oscillate of its own accord; the coupling between L-2 and L-1 might be loosened if desired. The tube is now acting in a regenerative manner and is strengthening the incoming signals. These are then induced in the circuit A which is in a state of self-oscillation. Interfering Spark signals are lost in the coupling but the continuous oscillations interact with those of A and cause beats which are audible in T.

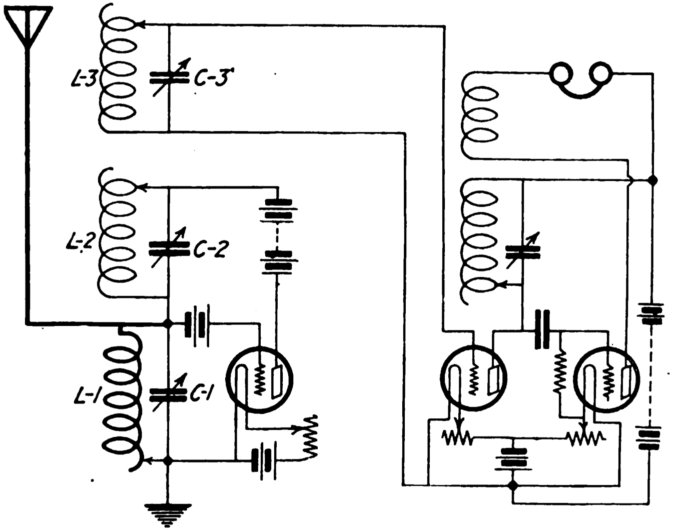


Figure 3—Circuit of a highly selective receiver

A rapid method of adjusting these circuits is as follows: Switch S to the right; increase the filament current of A until the circuit oscillates; tune C-2 until signals are heard; tune to the silent point of these signals so that the latter are heard if C-1 be varied either way. Switch S over to the left; see that circuit A is oscillating of its own accord; tune C-2 until a beat note is heard due to the oscillations of B. Decrease filament current of B till that circuit ceases to oscillate; the loud beat note in T due to B will cease, but by slight careful adjustment of C-2 the incoming oscillations will produce audible signals. The circuit A should be removed as far as possible from B, without decreasing too much the signals in T. If, while signals are being heard in T, the condenser C-1 is slightly turned either way, the strength of signals in T will decrease (owing to the mistuning of B) but the frequency of the beat note will remain unaltered since it depends on the local frequency of A.

The same disadvantages which applied to the B circuit alone still apply to the loose-coupled arrangement of A and B with the telephones in the B circuit. A considerable amount of spark interference may, however, be eliminated. Moreover, by suitably adjusting the coupling between L-2 and L-1 the incoming oscillations may be considerably strengthened by regenerative action. The signals in T will be weaker if advantage is not taken of this effect.

Having adjusted the "tuned" arrangement, let us now change back the telephones to the B circuit. Very loud signals will now be heard probably twice as loud as those heard on the B Circuit alone, and three or four times as loud as when the switch S is over to the right. The action of the circuits is now as follows: The B circuit is now accurately tuned to the incoming frequency and no loss is experienced through mistuning; also the oscillations are reinforced through the regenerative action of the coupling between L-2 and L-1, the degree of this coupling being just less than that required to set up self-oscillation in B. The A circuit, which is oscillating at a frequency slightly different to that of the incoming waves, induces oscillations in B which, acting on the oscillations already existing there, produce audible beats. The circuit B is not as receptive to local oscillations from A as it might be, but this is no disadvantage since the amplitude of the induced oscillations forced into the circuit may be adjusted to any value by varying the distance between the circuit A and B.

In the above circuits, high resistance telephones might be permanently connected in the plate circuits of A and B, the operator changing the receivers as required. There is no objection to the filaments of the two vacuum tubes being heated by the same accumulator.

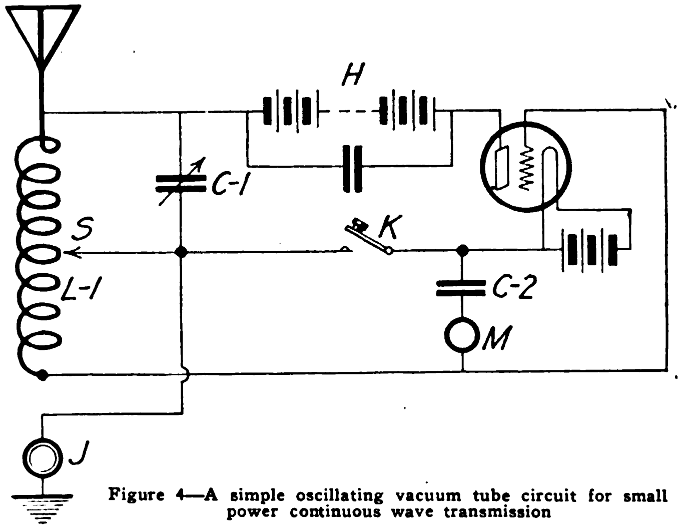


Figure 4—A simple oscillating vacuum tube circuit for small power continuous wave transmission

A Circuit for General Reception

The second circuit (Fig. 2) is intended for use as a general receiving circuit for damped or undamped waves. It has a particular advantage in that it does not radiate continuous waves while receiving this class of waves from outside. A circuit such as B in Fig. 1, when used as a receiver of continuous waves, is in a state of self-oscillation and radiates feeble waves of a slightly different frequency than that of the incoming waves. These feeble waves can generally be heard over distances of several miles so that another operator using a continuous wave receiver in the neighborhood will, if tuned, hear the vacuum tube of the other station oscillating. A continuous note will be heard. Two operators using a circuit similar to B of Fig 1 and searching for a certain transmitting station may completely prevent each other carrying out any work. Another phenomenon experienced sometimes is that of receiving continuous waves on an ordinary non-oscillating circuit. This happens when the receiving station is near another station (using an oscillating B circuit) which is tuned to receive the continuous waves. The two sets of oscillations are received, heterodyne each other, and are detected by the non-oscillating detector.

With the two circuits of Fig. 1 used in conjunction there is practically no radiation of continuous waves when receiving since the B circuit does not generate oscillations. With the circuit of Fig. 2 there is no radiation. Continuous waves pass inwards but are prevented by the first vacuum tube from passing out. The arrangement is, therefore, effective as a trap, and is likely to be made compulsory in the future.

The circuit consists of two vacuum tubes, the first one of which is used purely as a radio frequency amplifier and the second as a combined amplifier, heterodyne and detector. The aerial circuit is shown directly connected to the grid and filament of the first vacuum tube, in the grid circuit of which is a small dry cell B-2 connected so that the grid is made negative and therefore, prevented from taking an appreciable current. Magnified oscillations are set up in the plate circuit of the first tube which consists of the plate P, the oscillatory circuit L-2, C-2, the battery H and the filament. Oscillating potentials are set up across L-2 and are communicated to the grid of the second valve through the condenser C-3 of about 0.0003 mfd. A resistance R-1 of about 2 megohms is connected directly across the grid and filament and serves the usual purpose of a grid leak. If connected across C-3 (the more usual position) the plate battery H would affect the grid potential. This form of connection is applicable to many similar circuits.

In the plate circuit of the second vacuum tube is a small aperiodic coil L-3, a pair of high-resistance telephones (or a telephone transformer) and the battery H. The coil L-3 is coupled to the inductance L-2 so that the coupling may be smoothly variable. By tightening the coupling the circuits may be made to oscillate continuously at a frequency determined by the values of L-2 and C-2. These oscillations will not be communicated to the aerial circuit.

When standing-by for "spark" signals the capacity of C-2 is adjusted to zero, or the condenser may be switched out of circuit. The value of L-2 is kept fairly low and the coupling between L-2 and L-3 is made loose. All tuning is now done on the aerial circuit. The coil L-2 is then aperiodic and responds to all waves which are then rectified by the second vacuum tube.

When the station has been picked up, the plate oscillatory circuit L-2, C-2 is tuned to the incoming wave length, the coupling between L-3 and L-2 being adjusted to give suitable regenerative amplification.

When continuous waves are to be received, the aerial tuning inductance is varied in steps and search is made on the condenser C-2 which varies the frequency of the local oscillations which are to interfere with the magnified incoming oscillations passing through L-2. The coupling between L-3 and L-2 is, of course, tightened sufficiently to cause the second vacuum tube to oscillate of its own accord.

A HIGHLY SELECTIVE RECEIVING CIRCUIT

The circuit of Fig, 3 is one which may be used for receiving damped waves or continuous waves with a minimum of interference from other stations. The first vacuum tube is used as regenerative amplifying arrangement, the circuit being one suggested by Professor L. A. Hazeltine. The peculiarity and advantage of this circuit is that although waves to which L-1, C-1 and L-2, C-2 are tuned are amplified, the circuit tends to damp out and absorb waves of a length on either side. The amplified oscillations are now induced into the circuit L-3, C-3 and thence to a circuit similar to Fig. 2 in which they may be amplified regeneratively, or, in the case of continuous waves, heterodyned. The inductances L-1, L-2, L-3 may conveniently be wound on three cylindrical tubes sliding on a common central square rod.

A SIMPLE CONTINUOUS WAVE TRANSMITTER AND WIRELESS TELEPHONE*

Fig. 4 is a simple oscillating vacuum tube circuit which may be used for small power continuous wave transmission. Only one inductance L is necessary along which slides a variable contact A. A variable condenser C-1 is connected across the inductance L for tuning purposes and for altering the coupling between grid and plate oscillatory circuits. The battery H is of about 400 volts. Sending is accomplished by means of the tapping key K. A small flashlight bulb J is inserted in the earth lead and gives the brightest light when the circuits are correctly adjusted and the key depressed. This circuit will give an aerial current of about 0.4 ampere and will transmit a distance of about 30 miles. For wireless telephony, a condenser C-2 and microphone M are connected across the grid oscillatory circuit to modulate the steady stream of oscillations when the key is kept depressed. The range of such a wireless telephone is only a few miles. A suitable receiving circuit is an oscillating vacuum tube whose associated circuits are turned to the same frequency as the "carrier wave." No beats are received but only the speech.

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*See also the author's notes on the use of small power continuous wave sets, "Wireless World," April, May, June, 1919.

Novel Mica Condenser Construction

ERNEST ANSLEY WATSON has devised a very simple and practicable means of providing terminals for a copper foil mica condenser for use in ignition magnetos or wherever a compact form of condenser is required.

The alternate sheets of mica and conducting material are arranged so that the ends of the conductors or armatures project beyond the mica, the whole pile being clamped together by two metal clamps as shown in the accompanying drawing and which at the same time make contact with the two sets of conducting leads.

He has also arranged the pile so that, if desired, both ends of the conducting plates may project in each case in order that instead of two clamps and one connection to each set of plates, four clamps and two connections to each set of plates may be had, in which latter case the armatures are so placed that their projecting ends are on the opposite edges of the mica. This method of construction provides a solid and rigid condenser which effectively avoids the occurrence of trouble due to extreme vibration.

In a modification of this device, the alternate conducting layers may each be formed from a single strip which is folded back upon itself. Likewise, the insulating layers may be formed from a single strip.

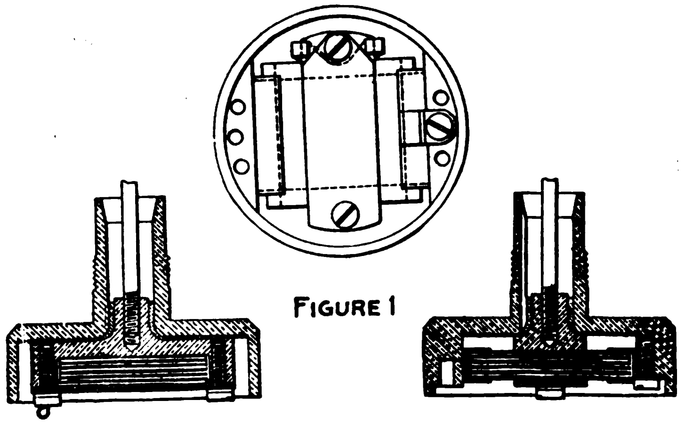


FIGURE 1

FIGURE 2

FIGURE 3

Detailed construction of the mica condenser

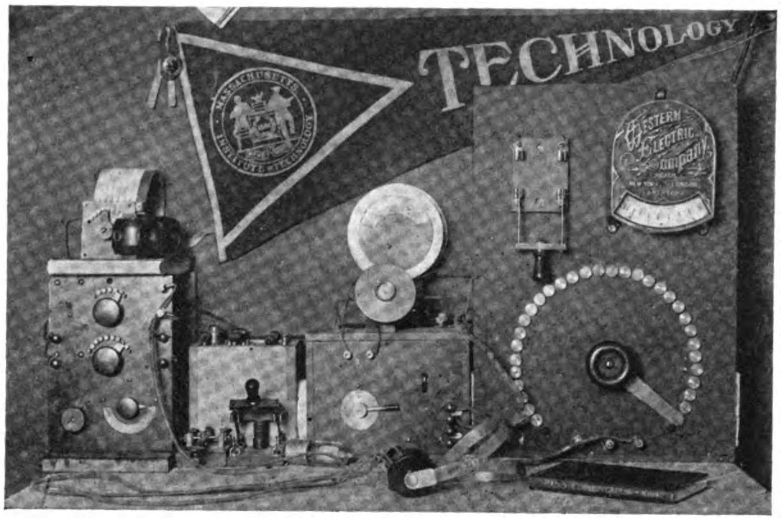
EXPERIMENTERS' WORLD

Views of readers on subjects and specific problems they would like to have discussed in this department will be appreciated by the Editor

A Simple Two Hundred Meter Radiophone

By Francis R. Pray

MY experience indicates that for radio telephony the simple circuit will give the amateur the best results and I am writing this article in an effort to show just how simple a small radiophone transmitter can be.



On the extreme right is the control panel which supplies variable D. C. to the plate circuit of the radiophone. In back of the panel is the rectifier (source of supply is 110 v. A. C. lighting current) as well as the filter box, for changing the derived pulsating D. C. to pure D. C. Next in line is the radiophone itself containing the oscillating circuit and power bulb. The microphone transmitter is shown on top. In actual practice, this will be replaced by a regular radiophone microphone. Above the radiophone is the hot-wire ammeter. The rest of the photo needs no description, being the usual receiving apparatus

In the circuit shown a very simple method of securing back-coupling is used as this method seems to be best for the small antenna. If a small coated filament power tube is available for use in connection with the set which I am about to describe, and reliable source of power and good antenna system is available, no difficulty should be experienced in covering distances up to 25 miles. Few amateurs perhaps, will be so fortunate as to possess a tube such as the Western Electric V. T. 2, but the Marconi vacuum tube may be used in a transmitter circuit as well as in a receiving circuit. For transmitter work, voltages up to 500 volts may be impressed on the plate and a transmitting range conservatively estimated at fifteen miles, may be expected from such a tube under favorable conditions.

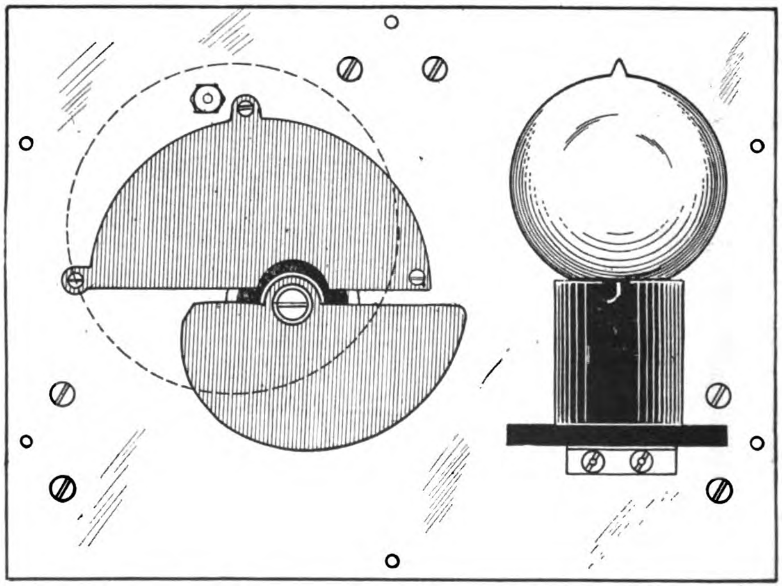


Figure 1—Showing variable condenser and the standard four-prong bulb

Before building the outfit some consideration must be given to the source of plate current. There are four means of securing this aside from the use of a motor generator. First, 110 volt A. C. lighting current may be transformed to the potential desired by means of a small closed core transformer. After being stepped up, the A.C. may be changed to pulsating direct current by means of two ordinary vacuum tubes in which the plates and grids have been connected together, the vacuum tube in this case acting as a rectifier. This high voltage alternating current may also be rectified by the use of an ordinary four jar chemical rectifier. In both these methods the resulting direct current is, as above stated, pulsating and must be smoothed out before being suitable for radio telephony. It may be done by shunting the pulsating direct current line with a 4 mf. telephone condenser. A large choke coil is then placed in each side of the line and each coil shunted by a 2 mf. condenser, and the line again shunted by a 4 mf. condenser. This combination of coils and condensers may be placed in a separate cabinet and such a device is usually termed a "filter." Small home-made storage batteries provide another source of high voltage plate current. For charging, these batteries may be connected in multiple and in series for discharge. Still another source of supply is to be had by use of flash light batteries. Although expensive, in the long run many amateurs no doubt will adopt this method.

The details of the apparatus used in the oscillating circuit are clearly shown in the drawings. The standard bulb with the four prong base is used in a standard socket and supported by a brass angle piece as shown. A piece of sponge rubber may be inserted between the angle piece and the panel to take up chance shocks, although this is not really essential since the cabinet is to remain constantly upon the operating table. The variable condenser should have a capacity of .0007 mf., of the General Radio type. The circuit should be calibrated and the wavelengths marked on the scale of the condenser, thus making it possible to set the transmitter at any wavelength within range, and avoiding in this way interference at the receiving station.

The inductance may be wound on a turned wooden disc 3½" in diameter. 26 turns of No. 22 D.C.C. wire will be required and will cover about ⅞". This coil will have an inductance of about 7 centimeters, and with the .0007 mf. condenser a maximum wavelength of 245 meters will be available. It is important that the coil be tapped at the 13th turn, and connected to the filament. The grid leak is of the order of 2 megohms, and may be made by placing a drop of Higgins India ink under the grid and filament binding posts and drawing a line (of ink) the thickness of which may be found by test, between the two. This is then allowed to dry.

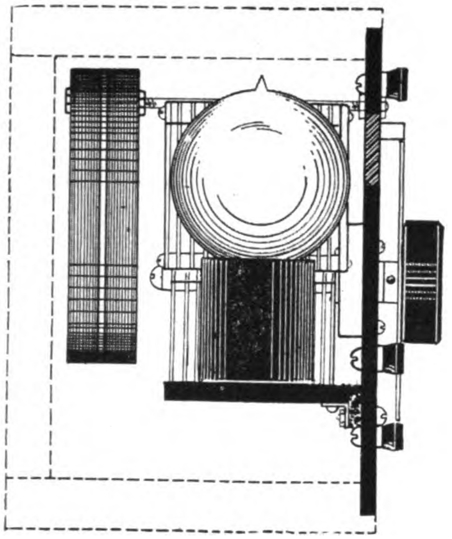


Figure 2—Side view of panel with instruments in place

The simplest method of modulating the high frequency current emitted is by placing the telephone transmitter in the ground circuit.

Since the filter box, generator, and rectifier need not be kept on the operating table, the radiophone takes up very little space, allowing plenty of room for the high power spark set for interstate communication. Such a radiophone as the one described is very convenient and will probably become standard for local work. A photograph showing the outfit described is printed herewith, a description of which may not be amiss. On the extreme right is the control panel which supplies the variable direct current for the plate circuit. Back of this control panel is the rectifier (source of supply is 110 volts A. C. lighting current) as well as filter for smoothing out pulsations of the rectified alternating current. To the left of the control panel is the radiophone itself, containing the oscillatory and power bulb. The microphone is shown on top. Above the microphone is the hot wire ammeter. The rest of the apparatus has to do with the receiving circuit which is similar to the one described by Mr. Sterns in a late Wireless Age, and which uses but one inductance and one capacity in the tuning circuit. It will be noted that the receiving vacuum tube is mounted in the rear of panel and observed through a hole.

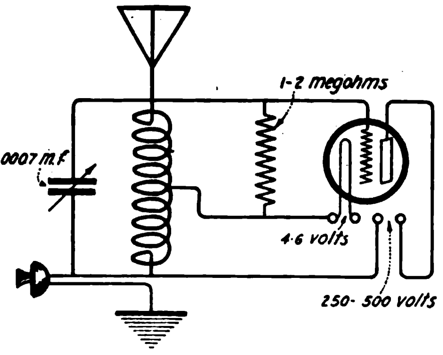


Figure 3—Circuit diagram used

Later research along this line shows that if the coupling between the halves of the inductance in the oscillating circuit is made variable, the bulb will oscillate better if a Marconi VT is used.

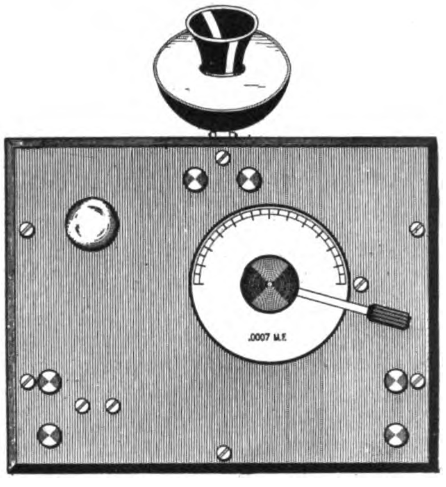
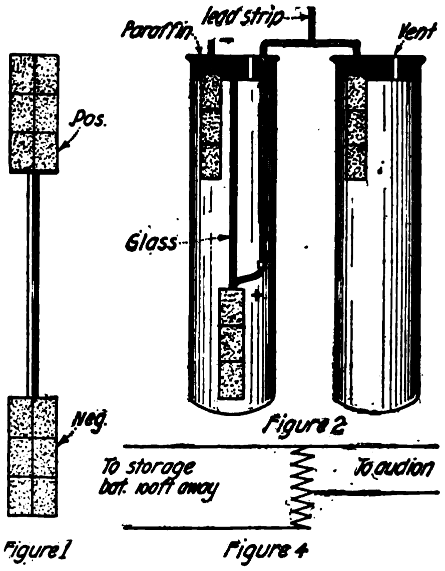


Figure 4—Radiophone containing the oscillatory and power bulb with microphone on top

In congested sections of the country, it would be best to connect the antenna circuit inductively to the oscillating circuit, instead of conductively, as shown in hookup, in order to provide sharper tuning. Otherwise, the wireless phone may interfere with the regular traffic. This third coil may have the same diameter as the other two coils but with about 10 turns of the same size wire, depending on the antenna constants.

"B" Battery for Audions

Two or three years ago, I made a 20 cell "B" battery of strips of lead inserted in test tubes ¾" in diameter and 6" long. This battery was not satisfactory as it lost its charge in a few hours even if not used. A few weeks ago I decided to try again and now believe I have solved the problem of a cheap and very satisfactory storage battery, and one that is very easily and quickly made. The positive and negative plates of some worn out batteries were sawed into strips—as is shown in figure 1—of the width of 2 rectangles and length of 3 rectangles and a strip of lead about ¼" wide and 1/16" thick was soldered to the part of the grid that formed the outside edge of the original plate. Unless all pieces are cut from the outside of the plate, difficulty will be encountered in soldering connections to the frail inner frame-work of the grids. The length of the connecting lead strip can be made to suit the size of the test tube used.



Detailed construction of the "B" battery

Figure 2 shows the position of the plates in the test tubes. One plate is above the other and is kept from coming in contact with the lead strip of the bottom plate by a piece of glass as wide as the upper plate and long enough to reach the top of the lower electrode. On 10 of the cells, I soldered a strip of lead about 2.5 inches long, shown in figure 2, to which the wires leading to the variable voltage switch were soldered. These were then coated with hot paraffine to prevent creeping of the acid, and the tops of the test tubes were also filled about ½" deep with melted paraffine after the acid had been poured in. With a warm file, vent holes were made through these wax plugs for the escape of gas and for filling when necessary. The cells were charged for several hours at a rate of ½ ampere to 1 ampere. They held their charge with no appreciable decrease for a long time; how long I cannot say as I have not yet tested that out fully.

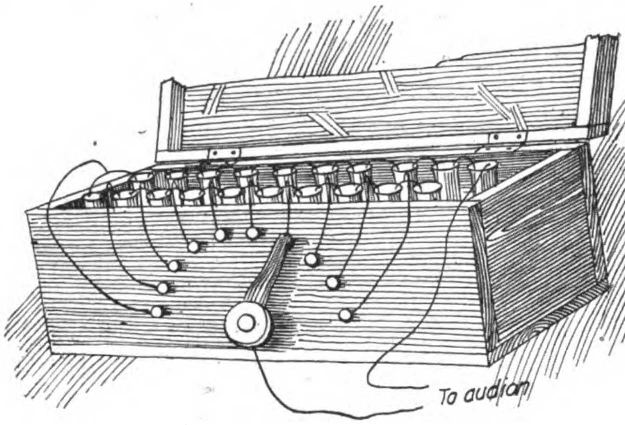


Figure 3—Voltage regulating switch

Another idea which I believe is new, for I have never seen it suggested, is to place the voltage regulating switch, figure 3, on the frame-work of the "B" battery. This requires only two wires from the battery to the audion. All the short wires connecting the cells to the switch points are eliminated and the "B" battery can be placed at a convenient place outside. The notion that the "B" battery has to be near the audion is erroneous as I shall show by the following: I connected the terminals from a 40-volt storage battery which was used to ring bells, run clocks and telephones, to a plain audion circuit. This battery is about 100 feet away and is connected to circuit, extending over a large three story high school building. The signals come in just as clear and loud from NAA and NAJ and other stations as they do with a regular "B" battery. The only objection is the audible click of the clocks every minute. With this battery I do not need to change the voltage; changing the filament temperature suffices. I presume the voltage just happens to be right for this particular bulb.

For my regenerative set the bulb requires a lower voltage and I solved this by shunting in a resistance coil to the battery, taking .1 ampere. A sliding contact was shunted from this as shown in figure 4. This set works as well as the other but the self-induction, when the circuits of the clocks are broken, sometimes chokes the audion and for this reason it is not desirable. However, it proves that placing the "B" battery a short distance from the audion is not essential to loud signals. I am hearing NWW every night and his signals are painfully loud, using either the "B" battery described above or the arrangement shown in figure 4.

In conclusion, I want to relate an experience of Friday night, April 18th, I was listening to NWW whose signals were coming loud and clear when all at once they stopped, seeming to indicate that a lead had snapped. Static drowned out everything on both long and short waves and the audion could not be coaxed to work at all. I tried opening the aerial switch when to my great surprise I heard NWW loud enough to read. I closed the switch, but the signals were drowned out again by static. NWW was heard again on opening the switch. I did this repeatedly for about 10 minutes when conditions became normal and NWW came roaring in on the aerial, but could not be heard with the aerial switch open. Will someone explain this peculiar occurrence?

JACOB JORJON—*Ind.*

Mounting the Panel Loose Coupler

IT is reasonable to assume that anyone undertaking the construction of a panel radio set is sufficiently advanced in the art to be quite capable of deciding for himself the arrangement of instruments, switches and controls he desires, and it is not the writer's intention to inflict another design on his equally competent fellows.

However, there is one feature of these sets so far submitted that may well bear improvement, namely, the method used in mounting the coupler and converting the reciprocating action of its secondary into a rotary motion at the control knob.

We will not consider the so-called "ring" tuners with rotating secondaries as the mounting of this type presents little difficulty. One soon finds that with this type all signals come in at maximum intensity with the secondary parallel to the plane of the primary. Likewise all signals fade together with the change of secondary angle, selectivity in this case being a matter of the strongest signal hanging on till the last.

The standard form of coupler is still the favorite and the mounting scheme shown in figure 1 will no doubt be of use to those who are casting around for ideas prior to building.

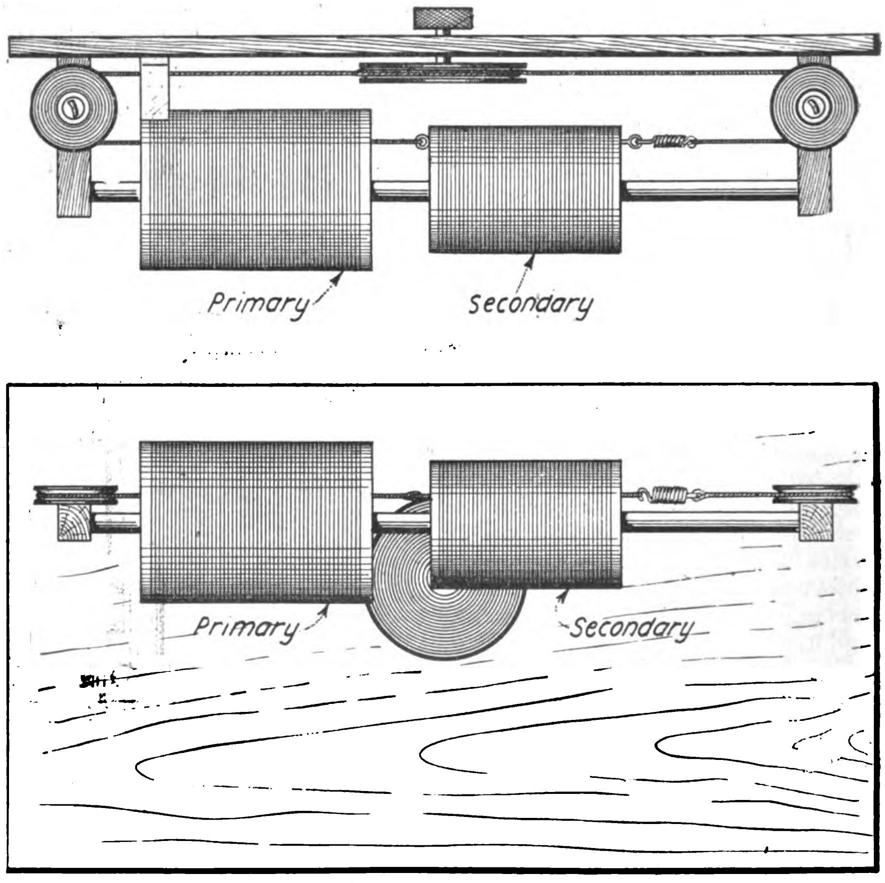


Figure 1—Standard form of coupler and method of mounting

The secondary slides on one slide rod only as the tension on the control cord counteracts any tendency for it to turn. This makes for less metal within the field of the coils and reduces friction and binding resulting from poor alignment. It is apparent that the removal of this one rod permits of easy access to all parts of the tuner.

If the grooved pulleys are made of wood, they will work best when bushed with short lengths of brass or fibre tubing. Hard rubber is more suitable and is satisfactory without bushing.

The main pulley is mounted on the shaft of the control knob and may carry an indicating scale on the side adjacent to the panel, the reading appearing through a small aperture as shown in figure 2. Obviously, the circumference of the pulley should somewhat exceed in length the total distance that the secondary traverses.

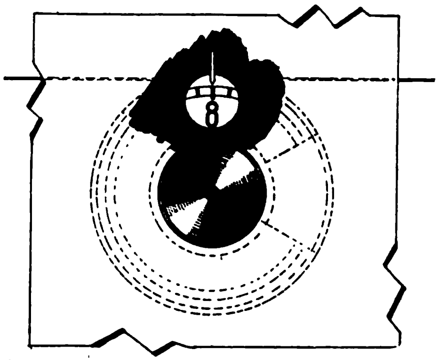


Figure 2—Indicating scale of the secondary coil

Each division on the scale indicates a uniform movement of the secondary and a small spiral spring will keep sufficient tension on the control cord to prevent slippage.

The primary mounting is standard in many makes of apparatus and consists of a strip of hard brass, bent to a convenient bracket form, and fastened to the panel independent of the secondary mount. When rigged as shown, a clockwise rotation of the knob loosens the coupling. This action can be turned about by mounting the primary at the reverse end.

C. H. BIRON—*Massachusetts.*

Direct Current Transmitting Apparatus

L. M. COCKADAY of New York City has developed a transmitting apparatus which operates off a direct current and which he claims will give 500 sparks per second, without difficulty.

It is to be noted that the circuits of figure 1 indicate the usual connections of a spark transmitter but there is included in the primary circuit of the transformer a rotary interrupter D-1 mounted on a shaft which also carries a rotary spark gap D-2. Contacts C equally spaced around the disc D-1 makes connection with two brushes which close the circuit to the primary of the transformer.

Discs D-1 and D-2 are set on the shaft so that the electrodes on D-2 will come into the sparking position just as the brushes on the disc D-1 break the primary circuit. The potential of the secondary of the transformer is then at the maximum and accordingly a spark will occur at D-2. By suitably shifting the stationary electrodes of the disc D-2, a position can be found where the maximum discharge can be

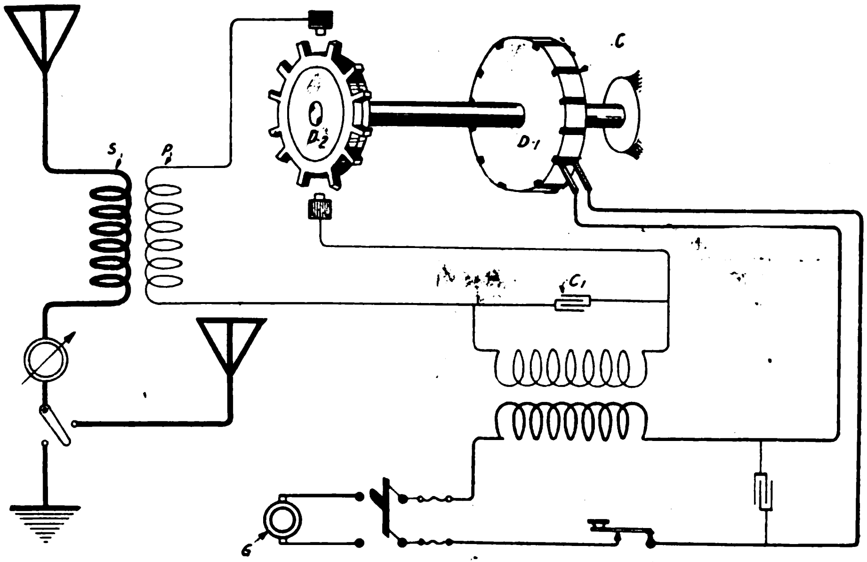


Figure 1—Circuit diagram and connections for the rotary interrupter

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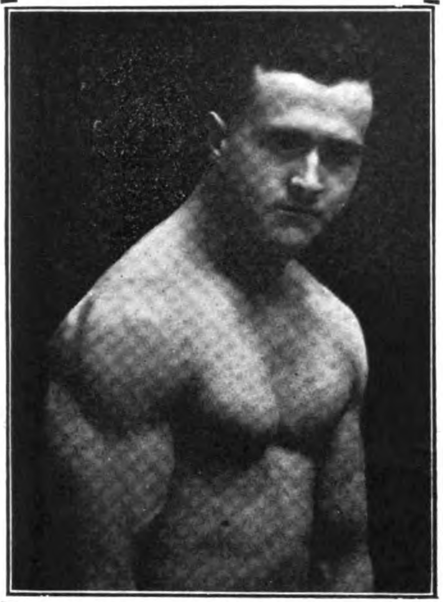

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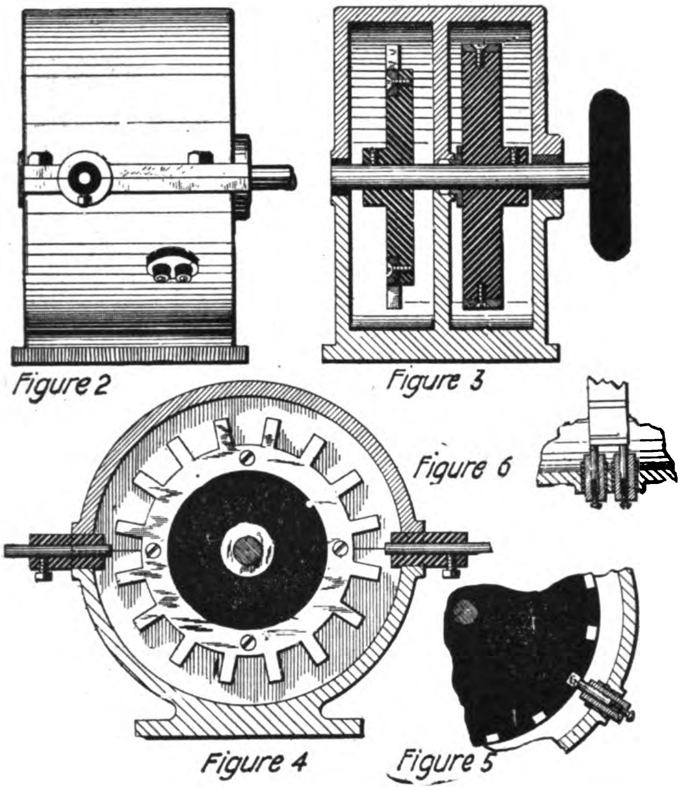
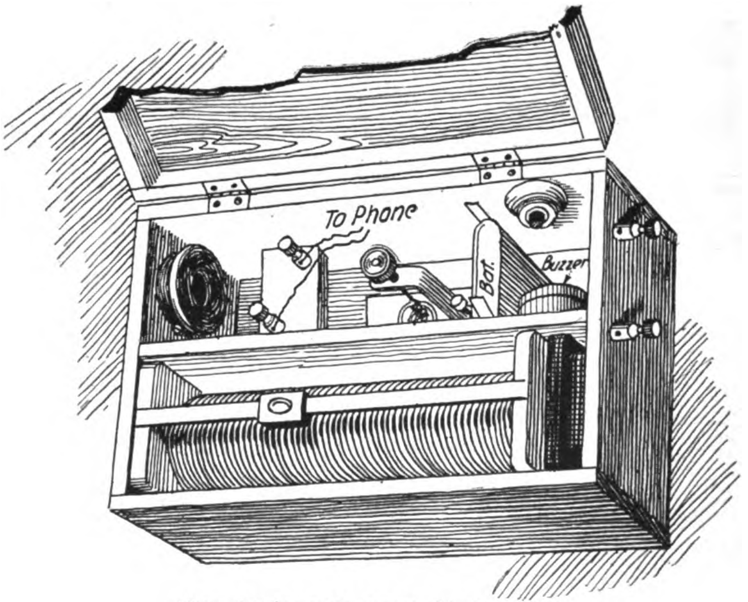


Detailed construction of the direct current transmitting apparatus

The inventor claims that he has operated this system with a 500 cycle transformer of usual construction fed with direct current. The source G is a direct current generator of a potential varying between 110 and 125 volts.

Portable Receiving Set

THIS small receiving set adds greatly to the enjoyment of a camping trip or a hike. The box in which the instruments are placed is 8" x 6" x 5". The set consists of a tuning coil, fixed coupler, condenser, detector and buzzer tester which is made up of a small flash light battery, buzzer and push button. The tuning coil is 7" long and 4" in diameter, wound with No. 28 B&S wire. The fixed coupler is made of three circles of cardboard, two 4" and one 3" in diameter. These are separated a half inch from each other. The primary is wound with No. 24 and the secondary with No. 26.



View showing arrangement of instruments

The detector is a large binding post with a cat whisker and a cup to hold the mineral. The condenser is of the fixed type; a small Murdock or a home-made one will serve the purpose. The buzzer is used to test the mineral. A flash light battery furnishes power.

Charles Wildonger—*New Jersey*

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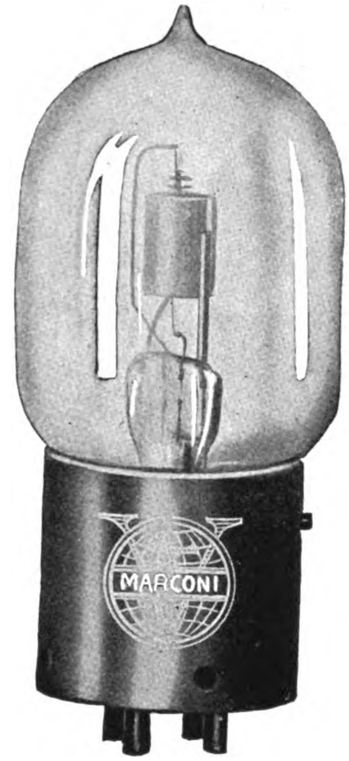

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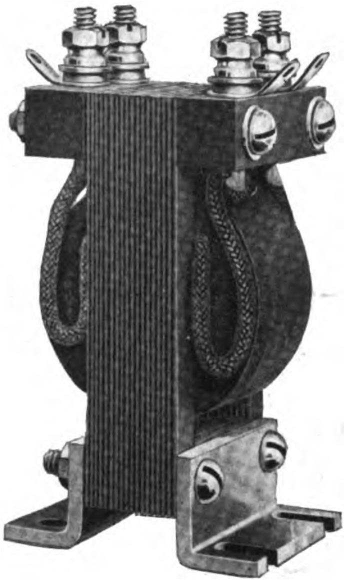

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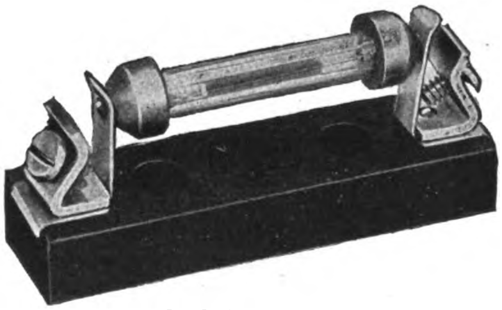

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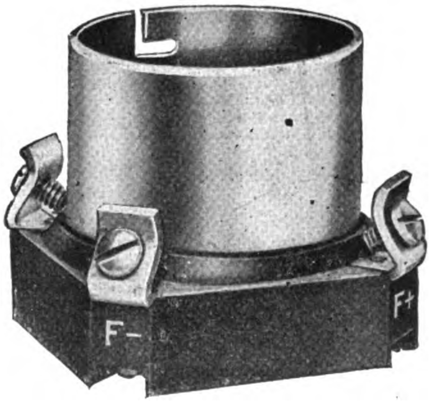

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First Prize—A 200-Meter Oscillation Transformer

By M. P. Koopman

THE average amateur does not come very close to getting the most out of his outfit. There are many reasons for this. The most common and inexcusable of these is the use of excessively long leads between the high tension condenser, the spark gap and the primary of the oscillation transformer. There are cases, of course, where there is no way out of the difficulty, but usually, given an oscillation transformer of the proper mechanical and electrical design, it is a very simple matter to so shorten these connecting leads that that portion of the inductance in the closed circuit which is external to the oscillation transformer primary itself is negligible.

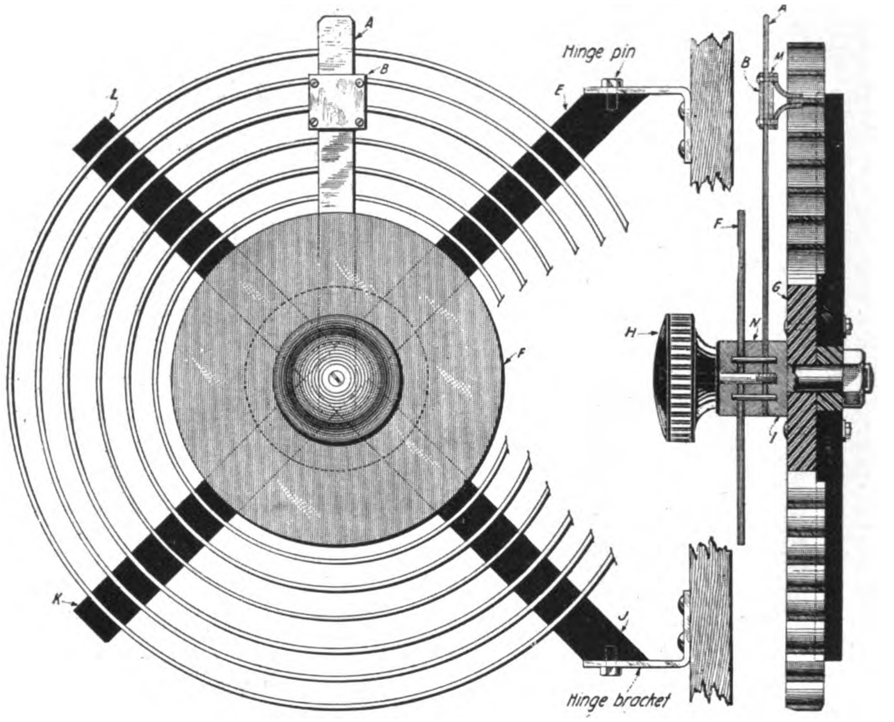

Figure 1—Assembly of the secondary of the oscillation transformer

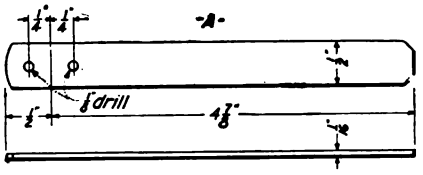

Figure 2

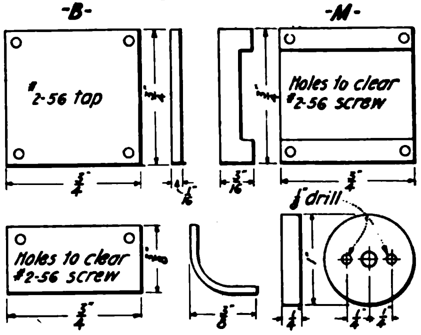

Figure 3

Details of figure 1

There is only one reason for an oscillation transformer. It is used to couple the closed circuit to the antenna. It can easily be proven that the percentage of electro-magnetic coupling between two circuits depends, among other things, upon what part of the whole inductance of the two circuits lies in the coupling coils.

It is very apparent that if it were possible to reduce the required number of turns of inductance in the closed circuit to one small turn the resistance of that circuit would be decreased. The inductance would also be decreased, and providing this single turn comprised the greater part of the total inductance in the circuit the coupling between the two circuits would still be of the proper order.

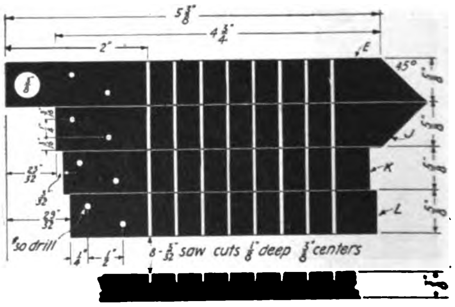

Figure 4—Dimensions of the spokes

To compensate for the inductance which we have now taken out of the circuit, capacity is added, and that is

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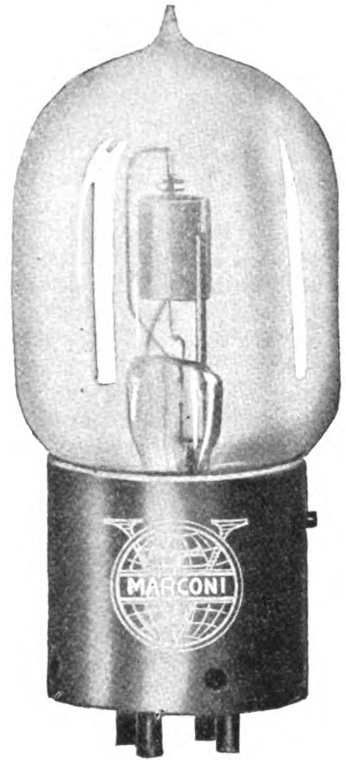

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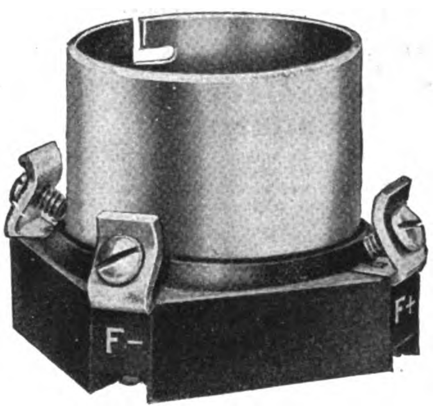

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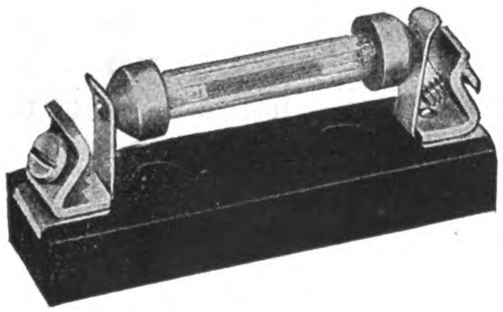

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what we are after, since at a wavelength of 200 meters it is extremely seldom that one finds even a half kilowatt outfit which is drawing full power.

Sketches are shown herewith, which it is hoped, may be of value to some amateurs—at least by way of suggestion. The assembly figure 1 shows the secondary of the transformer only. The frame of the primary may be made in the same manner as that of the secondary, excepting that only 3 turns of copper need be used. These may be placed opposite turns 3, 4, and 5 of the secondary, counting from the inside. Neither is a sliding contact so essential in the case of the primary. The wavelengths at which it may be desirable to work may be ascertained by the use of the wavemeter, and clips soldered to the primary turns at the proper points.

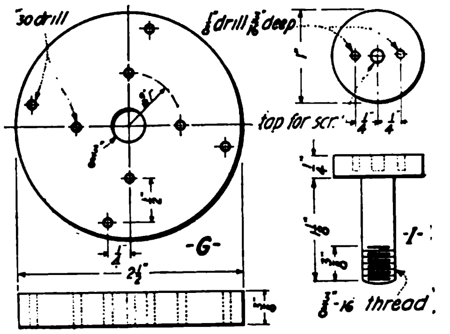

Figure 6 *Figure 5*

Constructional plan of shaft and bearings

The various parts of the assembly drawing and the corresponding details are lettered so that each part may be readily identified. Part A, figure 2, is a brass track for the movable slider figure 3 which is made up of the parts M, B, and C. The coil should be wound with soft-drawn copper strip 1/2" wide by 1/16" thick. The spokes, figure 4, are of rectangular dilecto rod 5/8" by 3/8". The sketches show the method of slotting for the copper strip. Before the copper is in position it might be well to drill a hole into each slot at the middle with a 1/16" drill. After being placed in position the copper may then be punched with a small center punch from the back. This will prevent the copper from coming out of the slots.

The main shaft or bearing screw I, figure 5, is made of brass and works in a dilecto bearing, figure 6, provided by parts E and G. The four spokes E, J, K, and L are fastened to the dilecto disc G by eight machine screws. On the front of the shaft I, parts A, N, F, and the knob H are assembled over two brass pins, as shown in assembly. F is a dilecto protecting disc to prevent brushing to the operator's hand while tuning the transmitter. The contact shoe, or slider, is put in place on the arm A and travels along the copper ribbon when the arm is revolved.

Connection to the arm should be soldered to the washer under the nut holding shaft and run along the back of the spoke E and connected to the upper hinge through a flexible braid. Connection to the inside end of the coil should be made and the connecting strip run along back of spoke J and connected to lower hinge in like manner. The primary connections may be taken care of in the same way. These connections are not shown in sketches.

A good arrangement for the closed circuit units is also shown in figure 7. Here the rotary gap is mounted on top of the high tension condenser which might also serve to support the small panel to which the spirals are fastened.

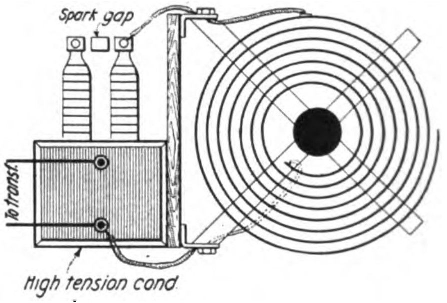

Figure 7—Arrangement of the closed circuit units

Second Prize—The Oscillation Transformer for 200 Meters

By Arlyn Rosander

Of all the oscillation transformers ever designed and placed on the market for the amateur none have, in the writer's opinion, ever surpassed the excellent features of the pancake type. The very fact that it is preferred in the most modern Marconi commercial transmitters and by the majority of prominent amateurs should surely be convincing, but the writer will, from a practical point of view, discuss why it is given preference above all other types. Before commencing the details, a few fundamental considerations of the oscillation transformer will not be found amiss. The functions of an oscillation transformer are: (1) to transfer energy from the closed circuit to the open circuit; (2) to vary the wavelength of either of the above circuits; and (3) by varying the coupling, to alter the character of the emitted wave. In order to get maximum efficiency careful consideration should be given to the following essentials. First, the primary and secondary coils should be wound with good conducting wire or ribbon. Second, the coupling should be easily and closely variable. Third, the coils should be well insulated between turns.

The amateur should realize that it is condenser charges in the primary that make for efficiency. Therefore, he should use as large a condenser as possible, leaving only two to three turns for the primary winding. Similarly in the antenna circuit, we should have just enough turns in the secondary for the safe transference of the energy. Five or six turns are sufficient to do this. Amateurs who depart very far from this will not be getting maximum efficiency.

No better oscillation transformer can be found than the pancake type employing copper or brass ribbon and using clips for variation of the inductance. This type presents the following desirable features and advantages over the helix and other types: (1) the coupling may be varied more easily; (2) it is easier to construct; (3) it is preferred for panel sets; (4) it is more compact.

It is obvious that it would be hard to get a proper variation of coupling if one were forced to use the helical type of oscillation transformer on a panel set. Using the pancake type, however, control of coupling is a simple matter.

The oscillation transformer used by the writer is simple and can be duplicated very easily. Although bakelite is the best material to use in the construction, it has been found that well seasoned wood baked in paraffin or shellac will compare favorably with the more expensive insulating materials. Two pieces of wood are placed at right angles to each other for each winding and secured to a base. Strips may be used to hold the ribbon in place, but it may be better to enlarge the cross pieces a little and saw slots into which the ribbon may be forced. For the primary, three turns of 1 1/2″ copper ribbon are used, the turns being spaced 1″. The cross pieces are 13″ long, the inside diameter of the winding being 6″. The secondary consists of six turns of the same material with the same spacing, the cross pieces being 16″ long.

Third Prize—An Oscillation Transformer for 200 Meters

By Howard W. Lewis

IN choosing an oscillation transformer suitable for use at 200 meters wave-length, one grades the various types in accordance with the following points. First, ease with which the self or mutual inductance may be altered; second, convenience and mechanical strength; third, simplicity and ease of construction. These qualities may be easily and economically attained in a type of construction which consists of two similar spirals, one of which is fixed, preferably in a vertical plane, and the other hinged so that the coupling between the two may be altered. The base for supporting each spiral may be merely a hard wood board, or, a better arrangement is a frame consisting of two wooden sticks 1 inch square and 10 or 12 inches long. These are notched together at their centers in such a way that they are at right angles to each other. Upon these crossed sticks is mounted a single row of porcelain insulators. Twelve will be required for each stick and they should be 3/4 inch apart on centers. The conductor passing the inductance proper is 1/4 inch copper tube which may be secured from almost any supply house. Ten feet will be required for each spiral. This will be sufficient for six complete turns. The tube is now wound smoothly on the frame. In most cases it will be found that the natural springiness of the tube will cause it to lie snugly in the grooves of the insulators. Where this is not the case, occasional tie wires may be used. In winding the tube on the knobs take care to avoid kinks and bends, as these are hard to remove and detract greatly from the appearance of the finished article.

When two spirals are thus completed, a base consisting of a rectangular board is provided. One of the spirals is firmly fastened at right angles to the base board using any convenient means. The second spiral is fastened to the base board with small brass hinges in such a way that it can be folded up closely and in a plane parallel to the plane of the first spiral, thus giving a maximum of coupling.

A system of four flexible leads or spring clips is now provided which serves to connect one spiral into the closed oscillatory circuit and the other spiral into the antenna earth circuit. the completed oscillation transformer may then be finished off to match the woodwork on the rest of the radio outfit.

It is apparent that any desired value of inductance for either the primary or secondary circuit may be obtained by shifting the spring clips and also, that the mutual inductance or coupling between the two circuits may be altered by swinging the hinged spiral toward or away from its neighbor. Also, the two spirals may be conductively connected in series in case it is desired to make use of the variometer effect.

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We will pay the usual prizes of $10, $5 and $3, in addition to our regular space rates, to the three contributors who send us the best manuscripts on the following subject by November 15:

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J. M., New York City:

In reply to your request for a diagram of connections and dimensions for a receiver to cover a range of 200 to 1000 meters for use in connection with a bulb or carborundum detector, note circuit diagram and dimensions below.

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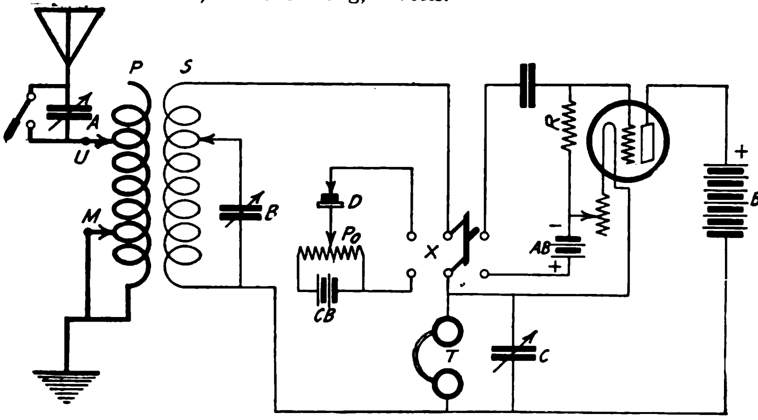

Circuit diagram for a receiver to cover a range of 200 to 1000 meters with a bulb or carborundum detector

In the circuit diagram A, B, and C are, respectively, the primary, secondary and telephone bridging condensers; U, the single turn primary switch; M, the multiple turns primary switch; D, carborundum detector; Po, 400-ohm potentiometer; T, telephones; R, grid leak resistance of from 4 to 6 megohms; X, a double pole double throw switch for changing over from carborundum to V. T.; AB, filament lighting battery; BB, high voltage plate circuit battery; and CB battery always required for proper operation of a carborundum detector. It should be about 4 volts, or if the resistance of the potentiometer is cut down to 200 ohms, 2 volts.

It is to be noted that the switch is so placed in circuit that changing from tube to crystal automatically opens filament circuit. When working with the tube, the telephones are placed common to wing and grid circuit and shunted by a variable condenser, thus providing capacitive coupling between the two circuits for regenerative operation. The three condensers A, B, and C, should have each a maximum value of .001 microfarad approximately.

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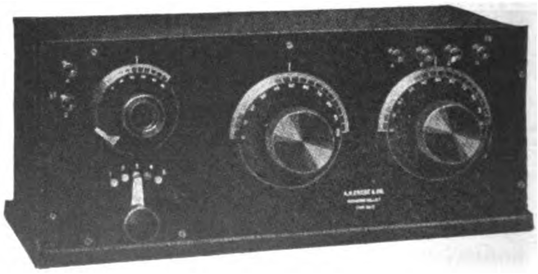

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Government Ownership Again

A GREAT many members have written to headquarters to inquire whether a call to action is to be expected, in view of the renewed activity in Congress on the subject of Government control of wireless.

The officers of your Association value highly the spirit which animates these evidences of the alertness of amateurs to protect their rights. We hope and expect members will continue to look to headquarters for guidance and we, in turn, will keep in closest touch with affairs at Washington so no one will be caught napping. The call to action will come, as in the past, if it appears that a crisis is impending, and we know from experience that a 100 per cent protest from individual amateurs will result. When amateur interests are not in danger, though, it is the Association's policy to let members of Congress pretty much alone, saving our letter-of-protest writing for a concentrated effort when actual danger signals are set.

At the present writing there are two bills in the House of Representatives and two documents affecting wireless. Two bills have also been introduced in the Senate, along with the two documents mentioned—letters from the Secretary of the Navy.

The House bills are H. R. 7288 and H. R. 8783. The first, introduced by Congressman Mapes, is concerned only with equipment of all passenger vessels with wireless apparatus. The other bill, introduced by Congressman Curry on August 26th, seeks authority for the handling of commercial radio business by naval stations. This bill and the two documents are of interest to amateurs. Document No. 159 is a letter from Secretary Daniels, dated July 19, containing a proposed bill giving permission to naval stations to handle commercial business. The bill proposed in the letter has not yet been introduced, in either the House or the Senate. The other document, No. 165, a letter written by the Secretary of the Navy, supplements the earlier communication and, in addition, seeks complete control or Government ownership of all radio stations. This proposal is substantially the one which the amateurs united to defeat last De-

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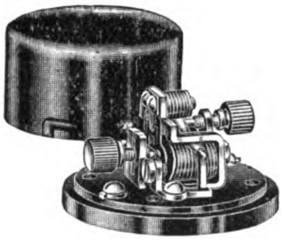

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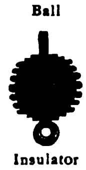

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cember. The hearings will be held, as usual, before the Committee on Merchant Marine and Fisheries, House of Representatives, at some future date. Thus far, no dates have been set and, on reliable information, it may be said that there is no immediate prospect of the bill's consideration by the House Committee.

The Senate Committee on Commerce is to consider a bill introduced by Senator Calder, S. 2523, which deals with the licensing of operators, but action on this relatively unimportant bill has not yet begun. Another bill, S. 1651, introduced by Senator Jones, mentions wireless in one article, although its substance deals with the cable situation. Reference is also made to radio in letters from various Government departments. Hearings will begin on this bill almost immediately, according to information just received. It is a question, however, if the amateurs' status will be in any way affected by this proposed legislation.

The principal matter for consideration, and possible concern, is the activity of the sub-committee of the Senate Committee of Naval Affairs. Senator Poindexter, as Chairman, has been holding hearings on the letters of the Secretary of the Navy already referred to. Up to the time of writing there have been three sessions, the first of which was executive and attended by naval representatives only; the succeeding public hearings have not been concerned with amateur affairs. During the progress of the hearings, however, a Navy-sponsored draft of a bill has been submitted, providing for complete Government ownership.

The heart of the question, so far as your Association is concerned, is that the hearings now being conducted by Senator Poindexter's committee are concerned with the propositions contained in the letters from Secretary Daniels. The Senate sub-committee is therefore only considering the advisa-

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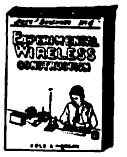

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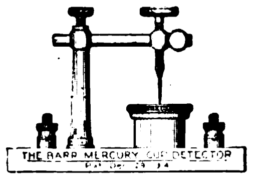
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bility of introducing additional radio legislation, not holding hearings on bills already introduced on the floor of the Senate.

The situation is not one to cause immediate alarm to amateurs. The progress of these bills and proposals will be carefully watched, however, and a campaign be organized instantly, should amateur communication be threatened with measures of extinction. Meanwhile, as in the past, it is the policy of your officers to withhold protests until the issue looks critical. It is hoped that members will not give themselves undue concern over the hysterical outbursts of those poorly informed. Your Association and its organ, this magazine, will keep you reliably informed and sound whatever warnings are needed, knowing that you will rise to the occasion and set Congress straight if our Senators and Representatives get on dangerous ground.

J. ANDREW WHITE,
Acting President, N. A. W. A.

Giving the Editor Facts

THE officers of the Association are anxious to enlist the co-operation of all members in securing proper representation of the amateur's case in the newspapers of the country. It is urged that the local papers be watched closely and when news items are printed giving only the viewpoint of the Navy on the subject of Government ownership, that an appeal be made to the newspapers to include an expression from the experimental side of the art. Specially important are the editorial columns, which should be closely watched. Editorial writers are eminently fair in estimating the merits of questions of public interest, providing both sides of the arguments are before them. Thus if some newspaper editorial looks unfair from the amateur standpoint it is up to members to write immediately to the editor of that newspaper. Such communications will be

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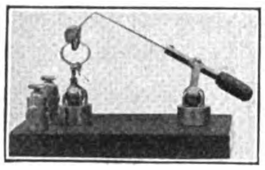

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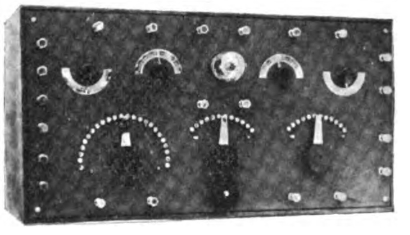

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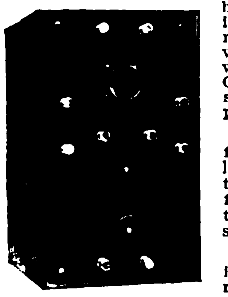

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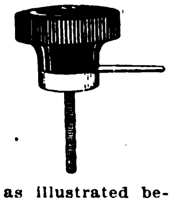

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published, if informative. For the guidance of members the following specimen is given, an item which was sent to the New York Herald from Association headquarters, immediately after Secretary Daniels' letters had been published and editorial comment made thereon.

This is how the communication appeared in that newspaper:

To the Editor of the Herald:

Your editorial of June 7 under the heading "Radio Control" gives some incorrect impressions as to the practical working of wireless. Exception is taken to the statement that government control over radio transmission is justified in peace "by the many difficulties and at times dangers caused previous to the outbreak of hostilities by the inconsiderate or mischievous work of uncontrolled operators."

I view this as an unjustified criticism of amateur wireless men, and one which has no foundation in fact. This whole subject was investigated by the House Committee on Merchant Marine last December, and the navy officials interested in putting through a government ownership bill had to frankly admit the great assistance rendered by amateurs.

Be reminded also that prior to the outbreak of hostilities it was an amateur who detected the unneutral messages from the German owned station at Sayville; also that the man selected as assistant to the Director of Naval Communications during the war was an amateur, and that the chief operator in Washington was a civilian commercial operator.

Your editorial assumes that official control by the navy need not interfere with amateur efforts. The testimony of radio experts and the decision of the Congressional committee gives the exactly opposite view. It is well established in the field of wireless that the short wave-lengths and low powers used in this experimental work insure that interference is practically negligible.

It should be understood also "the official and commercial demands" for message traffic through organized and authorized plants have nothing to do with the technical development of the art or working out "vexing problems that require free air."

J. Andrew White.

Eastern Amateurs, Attention!

By AUTHORITY of the Director Naval Communications, commencing about October 5th, a code broadcast schedule, addressed to all amateurs, will be transmitted by the Naval Radio Station, 44 Whitehall Street, New York, on 1500 meters. This broadcast will be transmitted immediately following the 9:00 P. M. press schedule.

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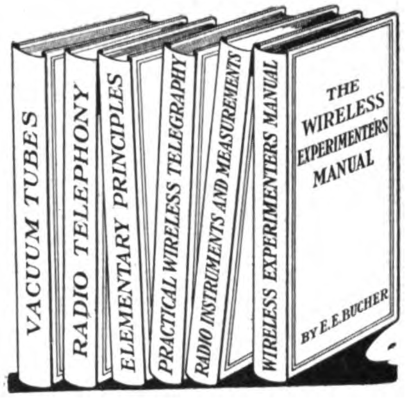
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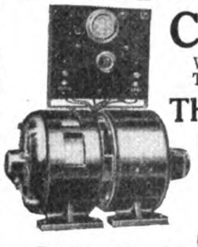

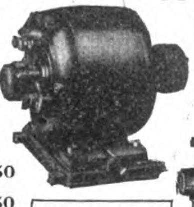

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tion of your primary inductance or by the use of a condenser either in series or in shunt with the antenna.

With an aerial having a fundamental wave-length of 200 meters the maximum range of your coupler, according to figures which you have given, is approximately 1000m. With this same arrangement coils having an inductance of 1,000,000 centimeters and 2,500,000 would tune up to approximately 1400m and 2100m respectively.

* * *

Wm. Eadie, Franklin, N. Y.:

Instructions for building a radio telephone which would serve your purpose fully, were printed in the June and subsequent issues of THE WIRELESS AGE. There is no information available concerning the "tube unit" and the "No. 2 oscillating audions" which you mentioned.

* * *

F. W., Los Angeles:

As far as we are able to gather from what you say concerning your outfit, you should be able to receive time signals with your present loose coupler. The fact that you get a humming noise after the 15th tap on the primary winding very probably indicates that the circuit is open at that point. It is reasonably certain that if your windings are intact you should have no difficulty. For the reception of wave-lengths up to 3000 meters, we would suggest that you provide yourself with an antenna 100 ft. or more in length and 50 ft. or more in height, at least. Your results will not be worth while on the longer wave-lengths with your present antenna. Your circuit diagram appears to be all right. If you wish to try for the longer wave-lengths with your present antenna a loading coil of about the same dimensions as the primary of your coupler would be advisable.

The hook-up which you have shown is suitable for the reception of wireless telephone messages. We do not know of any stations on the Pacific coast which are experimenting with radio phones. The wave-lengths used by aeroplane outfits usually run between 250 and 750 meters.

Inasmuch as you give us no data as to the number of turns on primary and secondary of your spark coil it will be impossible for us to tell you what spark length it should give and what battery you should use in connection with it.

* * *

E. H., Jersey City:

The two tone note of the New York Herald spark which you refer to is in all probability due to an improper adjustment of the transmitter and a faulty spark gap.

As we understand it, all the radio stations in and around New York are controlled from one point. This makes it possible to connect two or more stations so that they are controlled by the same manually operated key. It might be desirable to do this in case all the stations so connected were working on different wave-lengths in order that receiving operators who are tuned to the various standard wave-lengths might be reached without delay.

In answer to your question regarding circuits for the vacuum tube the regenerative circuit is preferred by most amateurs.

* * *

W. J. M., Charleston, S. C.:

We very much regret that, due to lack of information, we are unable to put you in touch with any one who can furnish you with the voice amplifier.

* * *

J. M., New York City:
(See page 38 of this issue.)

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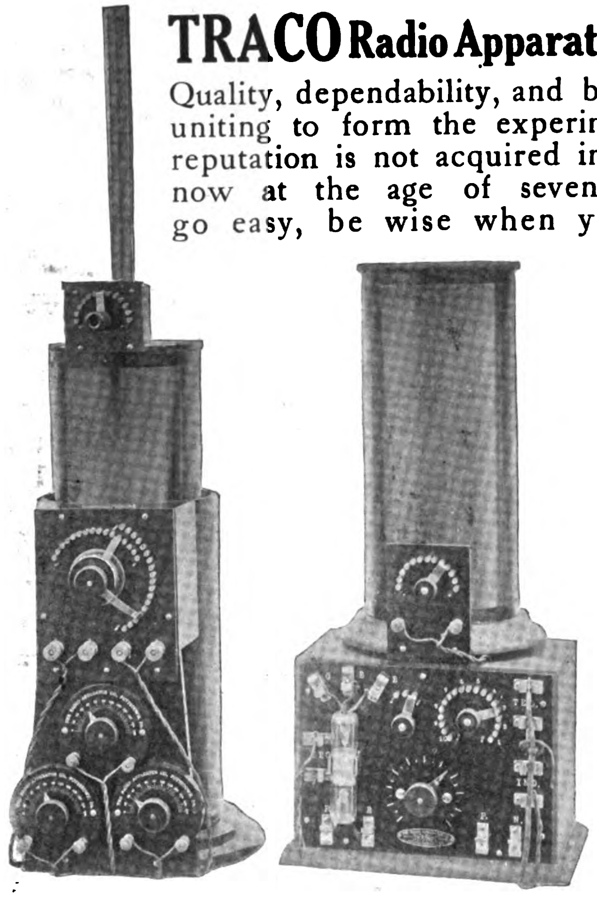
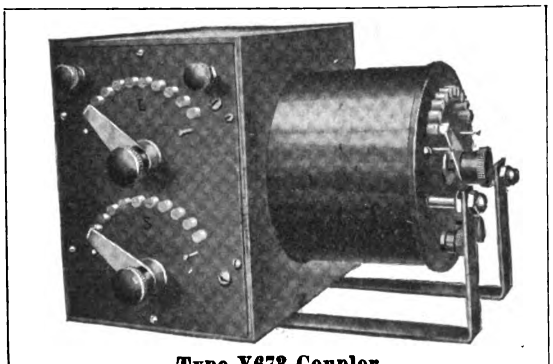


Type 93 Undamped Wave Set



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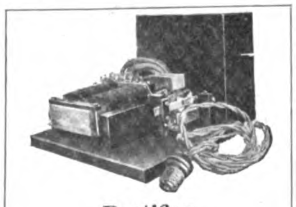

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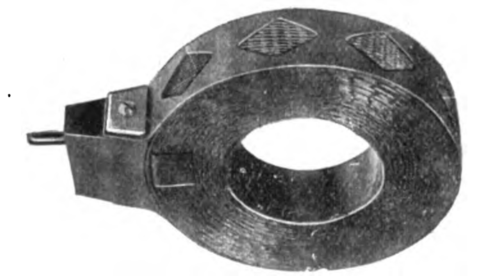

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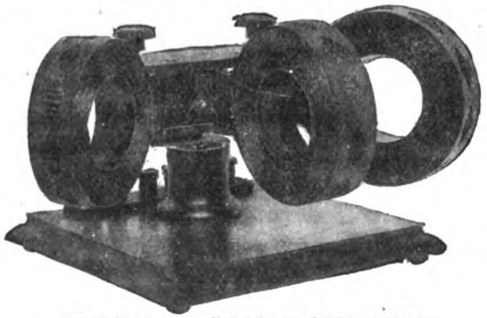

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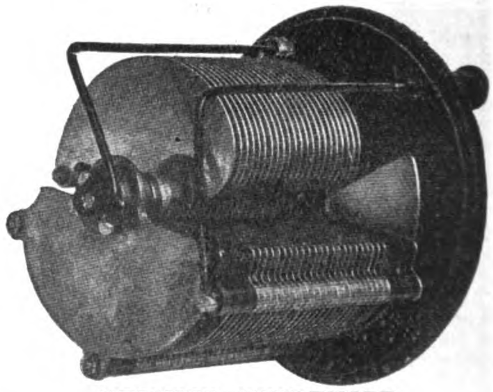

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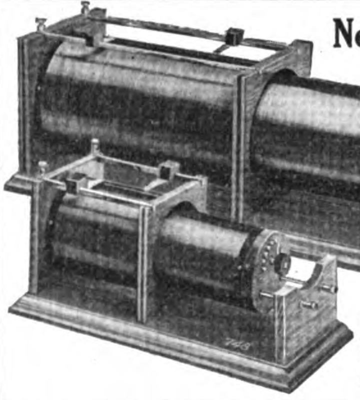

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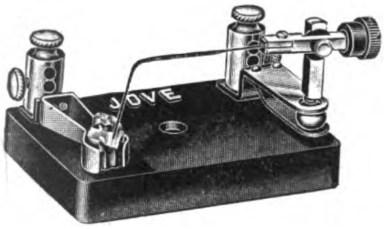

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Volume 7

Number 2

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Details of its organization

Across the Ocean on the NC-4

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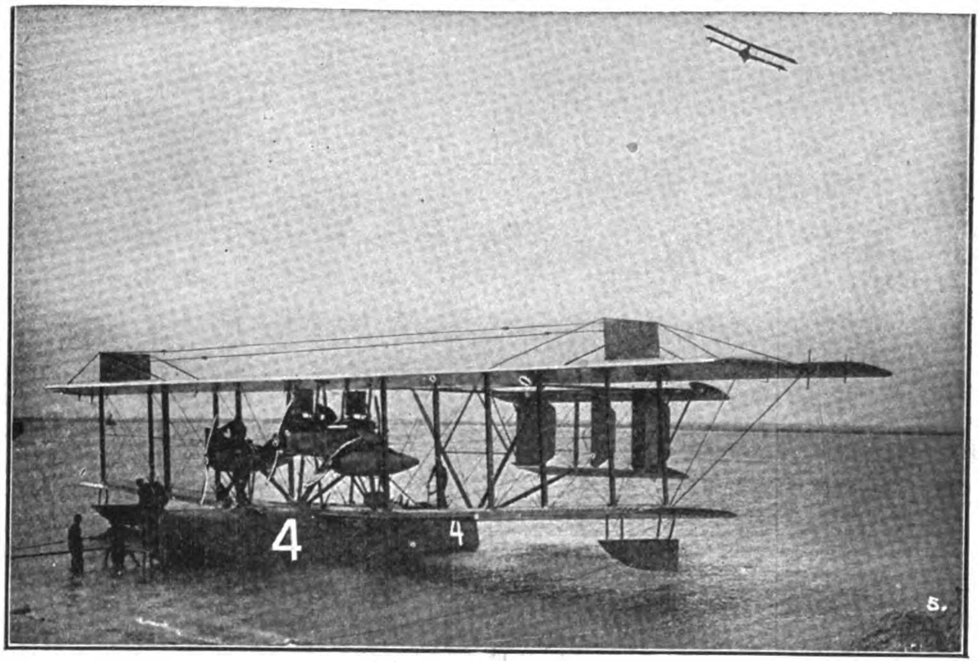
Extract from New York World, June 3, 1919.



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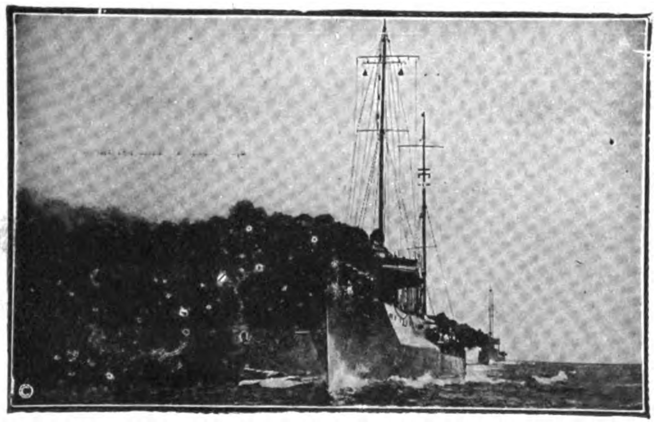

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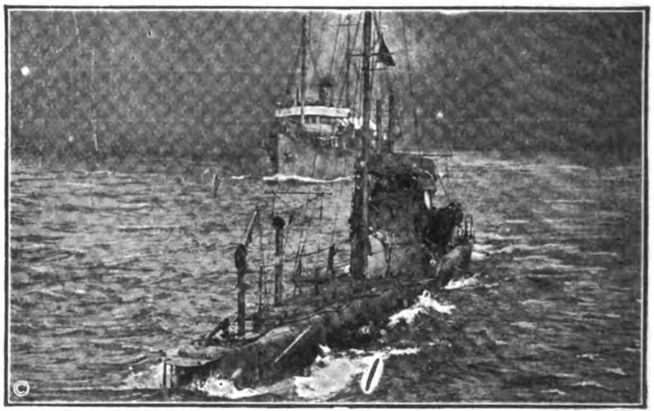

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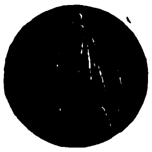

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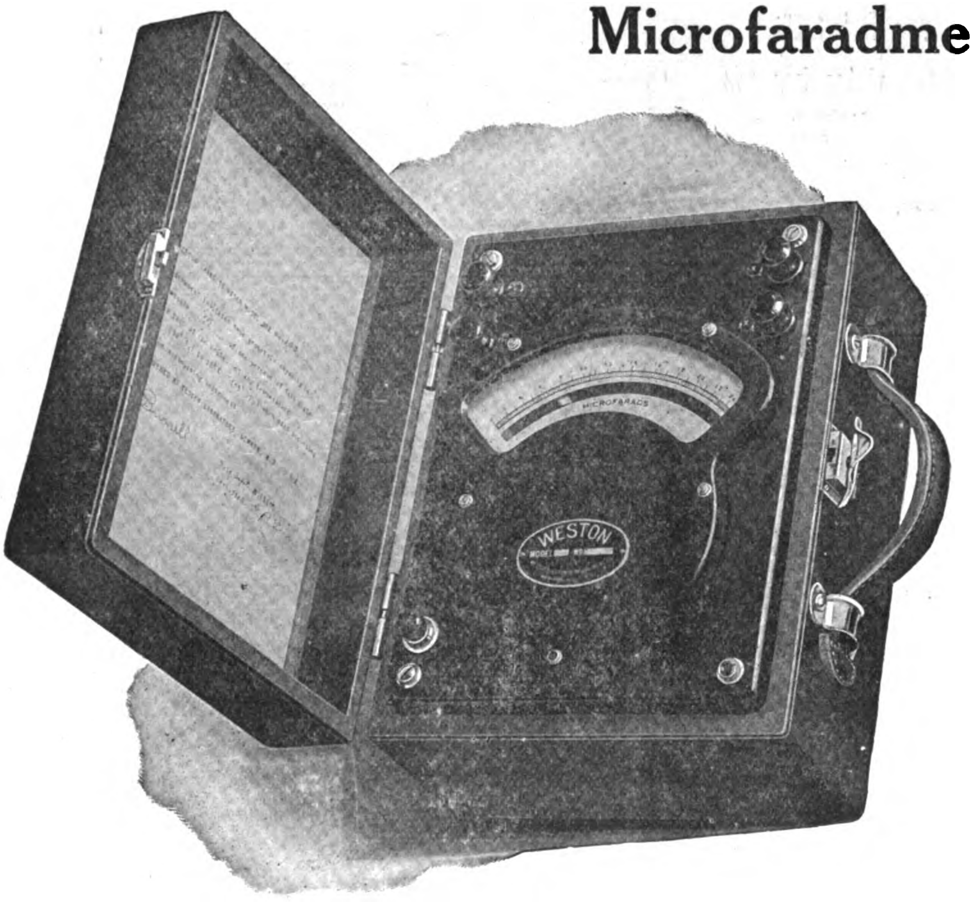

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THE WIRELESS AGE

Edited by J. ANDREW WHITE

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Vol. 7. **No. 2**

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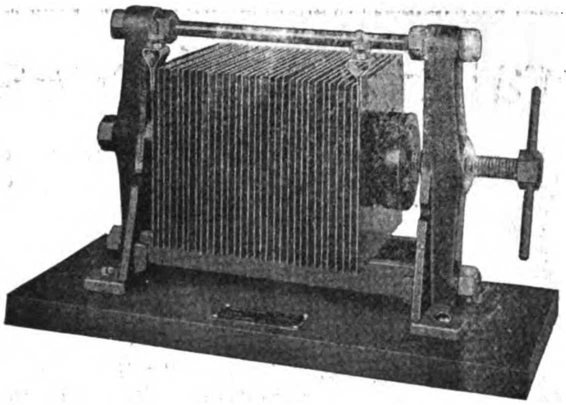

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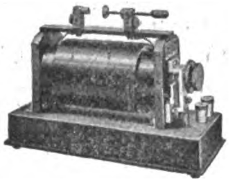

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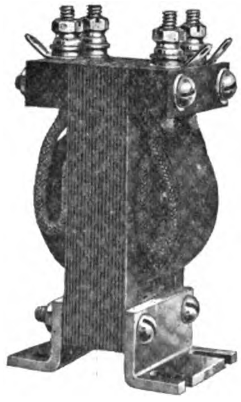

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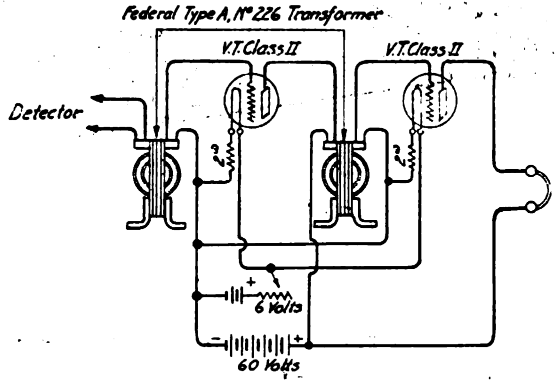

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will be the authoritative monthly journal of Wireless Research. Published in London at 2/6 per copy.

Edited by Professor G. W. O. Howe, D.Sc., M.I.E.E., assisted by Philip R. Coursey, B.Sc., A.M.I.E.E.

Papers from the greatest Radio Scientists of the World will be a special feature of the "Radio Review."

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THE RADIO REVIEW

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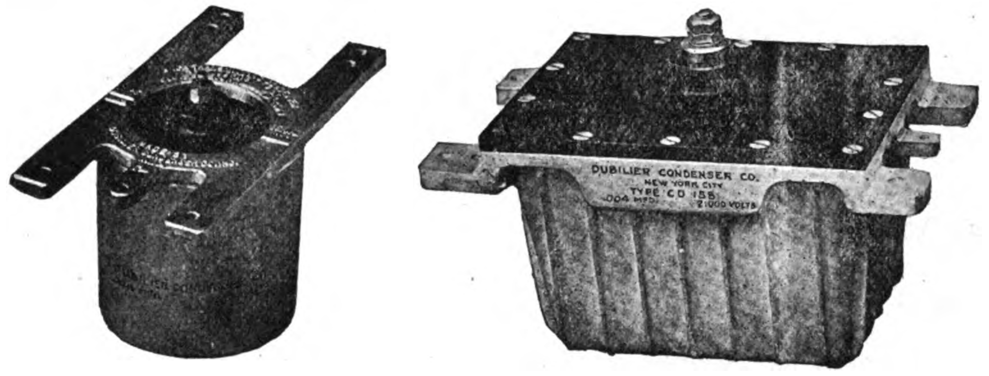

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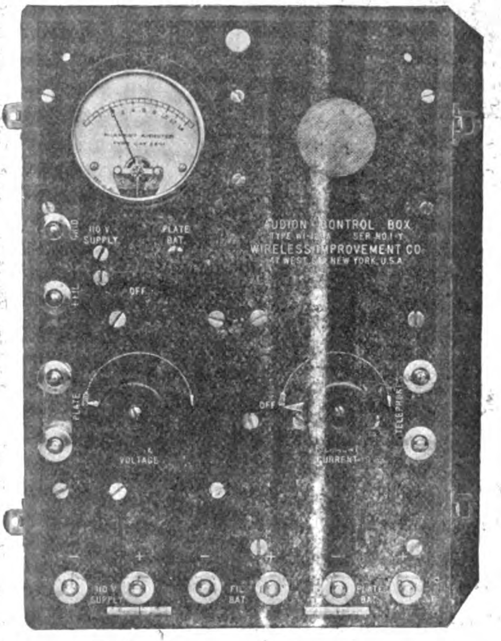

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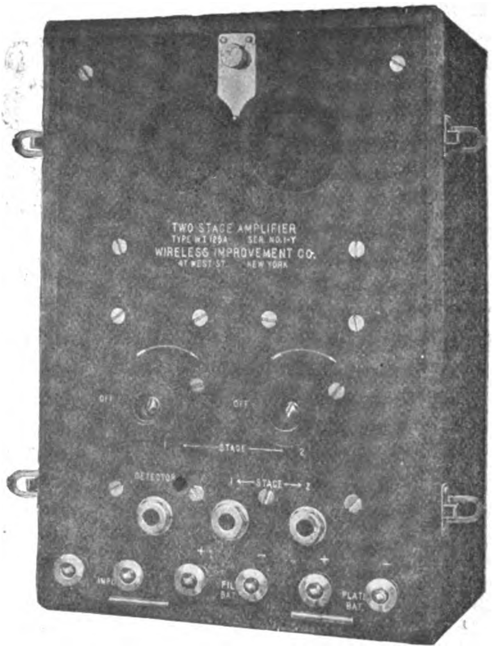

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47 WEST STREET NEW YORK, U. S. A.

Vol. 7. No. 2. November, 1919

THE WIRELESS AGE

WORLD WIDE WIRELESS

South Pole Explorer to Use Wireless

AN AIRPLANE hovering about the south pole may send to London daily wireless advices relative to explorations or scientific researches by the south pole expedition, which is to be led by John L. Cope next summer.

The explorer, who has served as surgeon and biologist on former south polar expeditions, believes the use of airplanes and wireless in probing the solitudes of the icebound antarctic regions will lead to revelations that will make the trip more important, from a scientific point of view than any previous explorations of the earth's "under side."

Although new difficulties will be created by use of aircraft, it is said the advantages to be obtained are so great as to be obvious to any one acquainted with such research.

It is proposed to equip the airplanes with wireless apparatus having a sending range of several hundred miles, insuring communication with the "mother ship" of the expedition. From this ship summaries of the airplane's exploits are to be flashed by more powerful instruments back to the civilized world.

* * *

Vienna to Become European Wireless News Station

TO MAKE Vienna the central receiving and distributing station of wireless news for all parts of Europe is the ambitious plan of a combine just founded in Germany.

A powerful radio receiving station has been established in the Hofburg, formerly one of the Hapsburg's favorite castles.

* * *

Wireless an Aid to Fishing

NAVAL SEAPLANES have been used to co-operate with fishing schooners in reporting prospective "catches." This co-operation is to be extended by the Bureau of Fisheries, Department of Commerce, in an effort to increase the supply of fish and reduce the cost of living.

War activities against the submarine developed the fact that bodies moving beneath the surface of the ocean were visible from an aeroplane, and this fact is being utilized to increase the fishing facilities of the country.

W. W. Welsh, of the Bureau of Fisheries has just completed his report upon an experimental flight from the United States Naval Air Station at Cape May, in which he co-operated with a fishing fleet.

Wireless telephone apparatus was used to report schools of fish to the fishing vessels below.

"At the time of the flight," the report says, "no schooling fish were breaking on the surface, and none could have been visible from the crow's nest of a vessel at short range.

"At an altitude of 800 feet some schools of menhaden were so near the surface that they appeared as a reddish brown granular mass, ameboid in character and changing in form constantly. Deeper schools had the appearance of large masses of sunken gulfweed."

Graphic News Bureau

The wireless telephone, installed in a Signal Corps truck and communicating with airplanes in the trans-continental flight, was recently exhibited in connection with the recruiting work of the Army

German Wireless System for Newspapers

THE GERMAN GOVERNMENT is experimenting with wireless with a view to extending its use internally. It is proposed to install stations in all the large German cities, and to utilize the wireless as an adjunct to the existing telegraph system. An especial advantage from use of the wireless is seen in its adaptation to newspaper purposes. A single story intended for a number of newspapers throughout the republic could be sent once from a central station and picked up by the substations in various cities. The technical work is just now being undertaken.

Wartime Amateur Wireless Restrictions Removed

WARTIME restriction governing the operation of radio stations and radio equipment by amateurs were removed October 1, by the Navy Department, as announced in the October issue. The removal applies to technical and experimental stations at schools and colleges and to all other stations except those transmitting or receiving commercial traffic.

The restrictions on commercial traffic stations will remain in effect until the President proclaims peace.

Regulation Likely to Be Government's Wireless Policy

WHILE Secretary of the Navy Daniels has by no means abandoned hope of persuading Congress to pass the Radio bill as drafted by the Navy Department, giving the Government a free hand in radio both for national defence purposes and commercial business, there are strong indications that Congress will not yield to any proposal leaning toward Government ownership of this method of communication.

A compromise has been suggested looking to the establishment of radio interests privately owned but controlled for national defence and other purposes by a Federal regulatory board or commission.

At the present writing the plan is tentative and there have been no commitments on the part of the Government and will be none unless Secretary Daniels can be convinced that the legislation desired by his department cannot be had. The Naval Affairs Committee of the Senate is now holding hearings on this bill.

One of the reasons demanding an early decision on policy by the Government is the fact that American business interests are already suffering from the forced use of foreign cables and wireless. Several instances are already known in Washington of American commercial houses engaged in foreign commerce whose messages have been delayed in transmission without explanation, thereby enabling their competitors abroad to get in bids and take other steps to secure business which might have come to the United States.

While it is yet too early to predict the course Secretary Daniels will take with reference to the Radio bill, and no action may result until the committees of Congress are ready to indicate their attitude, the general opposition in both Houses to anything savoring of Government ownership or monopoly now points to a solution of the question through private interests under Government control.

World's Baseball Series Reported by Wireless

AMATEUR wireless operators throughout Long Island, Connecticut and New Jersey had the benefit of the wireless report of the world's baseball series which was sent out each afternoon by the naval radio station at Whitehall street, New York. Word has been received from scores of these operators acknowledging the service.

Ships at sea were supplied with the news of the games at Cincinnati. Included among the vessels receiving the reports were a great many United States naval ships, on board which the interest in baseball is naturally high. Destroyers stationed up the Hudson as far as Yonkers benefited by the service and other war ships of varying kinds, stationed in waters near New York or travelling along the coast, also receiving it.

Far East Wireless News Service Proposed

ESTABLISHMENT of a transpacific news service with tentacles that will reach into the remotest parts of the Far East and daily bring the news of the now little known corners of the entire world to the breakfast table is proposed by V. S. McClatchy, publisher of the Sacramento Bee. He has appealed to the State Department at Washington to assist in this venture for according to his theory, the news service must be under the direction of the National Government during its inception.

Newspaper men who have given thought to the proposed advice agree that the daily interchange of news across the Pacific would probably have a greater effect in maintaining a world peace than any number of leagues organized for that purpose. Strong representations have been made on this matter to the State Department by the United States Ambassadors in the Far East, the acting Governor General in the Philippines and by commercial bodies whose interests lie in that direction.

Cable facilities are considered inadequate for this service and it is to be conducted entirely by wireless.

The communication to the Government urges that such a service be established at once; that service to Manila presents the least difficulties and should not wait for other connections; that while it may be necessary to start with a Government report, it be replaced by an independent report as soon as practicable; that the independent report be free from Government control or censorship, except in war; that where the Government report cannot be self-supporting, for a time at least, which may be true in China, the Government is to make such arrangements to meet the cost of transmission as will enable users of the report to secure it at a price within their means.

British Wireless Export Ban Removed

A CABLEGRAM from Consul General Hollis at London, announced that the British export embargo on wireless telephone and telegraph apparatus and instruments has been removed.

International Cable and Radio Conference

PRESIDENT WILSON has asked Congress if it would authorize the proposed International cable and radio conference in Washington, D. C., next month.

A recent law prohibits the executive from giving or accepting invitations to international conferences without express authority of Congress. The principal allied powers expect to participate.

Under-Water Wireless

COMMUNICATION by both radio telegraph and telephone has been established between a hydroplane and a submerged submarine lying several fathoms under water off Fishers Island, six miles from New London, Conn. The experiment was watched by 250 members of the Edison Society of Electric Engineers.

The engineers were taken on board the destroyer Blakeslee and a Government submarine chaser, where they listened in through wireless sets to the submarine N-6 and a hydroplane which was flying overhead. The destroyer's wireless outfit also established communication between the submersible and the airship.

Mexican Station at Salina Cruz

THE PRESIDENT OF MEXICO has ordered the work of the installation of the wireless station at Salina Cruz to be speeded up and to terminate it as soon as practicable. This station will communicate directly with the Republic of San Salvador. The station will receive messages from other stations that are established in the republic and abroad, but especially so from San Salvador, as this has been the main purpose of its installation agreed to by President Carranza.

* * *

Forestry Service Wireless System

THE ESTABLISHMENT of a wireless telephone system on top of the new postoffice building at Portland, Ore., for the use of the forestry department in conducting experiments as to the feasibility of establishing this means of communication throughout the national forest system in the northwest is progressing and the system will soon be ready for trial.

Recently the forest service carried a wireless telephone outfit to the top of Mount Hood and received messages there with perfect success. In carrying out the experiments from the new postoffice building it is probable that other stations will be established at Zig Zag on Mount Hood and at Wind River, north of Carson, Wash.

* * *

In Honor of Marconi

THE National Electric Light Association announces the organization of a special committee on the Marconi Fund for Italy at the suggestion of the Italian War Relief Fund of America.

The appeal now being circulated states that the moment is believed to be propitious for honoring the services to mankind of Marconi, and at the same time for showing the appreciation of Italy's great sacrifices and achievements in the war, by raising a special fund in the name of Mr. Marconi for immediate work in relieving the distress of Italian war orphans and blinded and mutilated soldiers and other war victims.

The retirement of the American Red Cross and the Y. M. C. A. from the suffering peninsula makes it vitally imperative that the Italian War Relief Fund be continued through this trying and critical winter and to this end a committee to represent the electrical interests of America in the matter has been formed, composed of Elihu Thomson, John W. Lieb and T. Commerford Martin.

The appeal of the committee to electrical workers contains the following:

"We feel that everything that can be done must be done to give to the Italy that fought for us two weary and bitter years before we entered the war that has saved civilization, a further proof of American friendship and sympathy. She has profound claim on the respect and good will which we electrical engineers and all others engaged in electrical affairs can express through her great son, our friend and colleague. The effect upon Italo-American relations is sure to be salutary on both sides of the Atlantic."

Criminal Captured by State Constabulary Through Wireless

TROOPER E. C. ROBERTS, of the Brewster Station of the New York State Constabulary ordered the arrest by wireless of Nicholas Toleff, charged with murder in Jamesville. When the suspect was four days out at sea on the steamship Pannonia of the Cunard Line. The ship was destined for Piraeus, Greece, and was not due to make a landing for fourteen days.

The defendant is accused of murdering Christo Bozenoff. The trooper traced him from Jamesville to the Cunard dock in New York City, where they established that he sailed with a Serbian passport. This is the first time the State Constabulary has effected an arrest by wireless. The ship officers were asked to return Toleff to the United States.

Graphic News Bureau

The latest of Uncle Sam's super-submarines, the H-2, is equipped with the most modern wireless apparatus which permits the sending and receiving of radio messages while submerged or afloat

The First U. S. Wireless Station in Siberia

THE FIRST United States naval radio station in Russia was opened this year at Vladivostok by naval engineers who went to Siberia in November, 1918. G. K. O'Leary, mechanical engineer in the employment of the navy returned on the army transport Sheridan recently, after the completion of the station. It is one of the finest in all Asia, according to O'Leary.

* * *

American Legion Radio Post Formed

GEORGE GUYNEMER, famous French ace, will be honored by a post of the American Legion, which is to bear his name. It is proposed to make this post the "Radio Post," and all New York men who have served in the radio service of the army, the navy or the marine corps are urged to join.

The members of the new post are also planning the erection of a radio receiving and transmitting station at their headquarters in New York. Among the organizers of the post are:—Edgar H. Felix, Will T. Weatherbee, J. E. Howay, Donald D. Way and Harry A. Burgess.

A New and Powerful Wireless Company

Details of the Scope and Purpose of the Radio Corporation of America Which Will Have Behind It the Combined Achievements of the American Marconi Company and the General Electric Company

During the war the art of long distance wireless communication progressed to such an extent as to make it clear that this new means of communication is quite as reliable as the cables. The crowded condition of all communication facilities, particularly cables, is such as to make it necessary, from the point of view of the commercial interests of the country, that this new factor in communication should be developed as rapidly as possible. Political, diplomatic and national reasons require that there should be ample radio facilities in the hands of one or more exclusively American concerns.

The Marconi Wireless Telegraph Company of America, which is the largest and strongest wireless company in this country, has the disadvantage of having a substantial percentage of its stock held abroad, and because of patent agreements with the British Marconi Company, of having its operation limited to the United States. The research laboratories and engineering force of the General Electric Company have been working for a number of years on radio matters and radio apparatus of great value has been developed which was used by the Government during the war for important communications. These two factors are basically considered in the formation of a new corporation called the Radio Corporation of America which has taken over the radio rights of the General Electric Company and which has proposed to the American Marconi Company to take over its patents and stations and some other of its assets. The directors of the American Marconi Company have approved this arrangement and have called a meeting of their shareholders on November 20th, to pass upon it finally.

If this proposed arrangement goes through the block of shares in the American Marconi Company held by the British Marconi Company will be acquired by the General Electric Company, and steps will be taken immediately under contracts and concessions already in existence to set up high grade commercial communication with England, France, Norway, Japan, Hawaii, Cuba and South America. It is proposed to extend the communications to China and various other countries as rapidly as possible.

Arrangements will be made that provide for the new company to remain permanently under American control. It will be amply provided with capital; none of its stock is offered on the market. It will enjoy the full technical assistance of the General Electric Company and of its research laboratories and will retain the highly developed staff of the American Marconi Company.

The new company will enjoy exclusively the patent rights of the British Marconi Company for the United States and Cuba and will be entitled to licenses under its patents in various other countries. In addition it will be in a position to enter into traffic arrangements with respect to communication in various important countries.

Mr. Edward J. Nally, who has spent his life in the communication business and for the past six years has been Vice President and General Manager of the Marconi Company, will be the first President of the Radio Corporation, which will have a strong board of directors.

Over the signature of John W. Griggs, as President of the Marconi Wireless Telegraph Company of America, the following circular containing the full proposal has been sent to Marconi stockholders:

The principal aim and purpose of the Marconi Wireless Telegraph Company of America, during all the period of its existence, has been the establishment and maintenance of transoceanic communication. Although the Company has done no inconsiderable business in minor branches of the wireless art, such as the equipping of vessels, the operation of ship to shore traffic, the manufacture and sale of wireless apparatus, and the collection of royalties, yet these have by the management been always considered as incidental to the greater and more profitable business of long distance communication.

When the war came your Company had erected, and nearly ready for operation, long distance stations at New Brunswick and Belmar, New Jersey, for co-operation with similar stations of the British Marconi Company in Great Britain. It had long distance stations on the Pacific Coast, near San Francisco, and on the Hawaiian Islands, for communication with Japan; and it had in the course of construction stations at Marion, Mass., and Chatham, on Cape Cod, for communication with Norway. Your Company has recently purchased the station at Tuckerton, New Jersey, intended for communication with France. At the beginning of the war the British Government, for its own use, took over all the British stations, thus preventing any use of our New Brunswick and Belmar stations; and when the United States entered the war our Government took over the Tuckerton station and all of our stations; thus any use of our stations and all development of the business of transoceanic communication has been absolutely suspended and will remain suspended until the Navy Department, under whose administration wireless affairs have been conducted for the Government, permits us to resume operations. This must happen soon; when it does happen your Company will, except for the objections hereinafter mentioned, be free to complete its preparations for engaging in long distance business. The revenue which will be realized from such operations will be particularly necessary because of the cessation of the extraordinary demand for small wireless outfits created by the war.

As you doubtless know, the American Marconi Company was organized as a co-relative of the parent British Marconi Company, receiving a grant of the Marconi patents and inventions for use in the territory of the United States and Cuba only, and under the expectation that it would, under a traffic agreement between it and the British Company, conduct a wireless service between the United States and Great Britain. The British Company has always held a substantial stock interest in the American Company and the plans and policies of the two have contemplated mutual co-operation and control so far as trans-Atlantic service is concerned. Two of the officers of the British Company have been officers of the American Company, viz: Senatore Marconi, as a director and vice-president, and

Mr. Godfrey C. Isaacs, who is Managing Director of the British Company, as a director.

Owing, no doubt, to the greatly increased use of wireless by the United States Government, especially during the late war, during which all wireless operations, both of commercial stations and naval stations, have been under the control of the Navy Department, our Government has come to regard the subject as one of very vital importance to this country, especially from a military standpoint.

As you have been informed by means of the report of hearings in Congress which have been mailed to each stockholder along with the annual report of the company, the Navy Department has sought to procure the adoption by Congress of legislation to vest solely in that department the right to operate wireless stations and to carry on wireless commercial business.

Congress has so far refused to pass any such legislation and the Committee of the House of Representatives, to which bills for that purpose have been referred, has in each instance refused to report them, clearly evidencing the opinion of Congress that commercial wireless business should be left in the hands of private companies rather than be made a subject of government ownership and operation. Notwithstanding this, we have found that there exists on the part of the officials of the Government a very strong and irremovable objection to your Company because of the stock interest held therein by the British Company. This objection is shared by the members of Congress to a considerable extent. Consequently your Company has found itself greatly embarassed in carrying out its plans for an extensive transoceanic traffic, and unless this British Marconi interest in your Company is eliminated your President and Board of Directors believe it will not be possible to proceed with success to the resumption of its preparations for a world-wide service when its stations shall be returned to it, as they will be in the near future. Even in the minor branches of your Company's work, which branches have been quite profitable during the war, the objections above alluded to have been increasingly effective in limiting your Company's activities. For example, the United States Shipping Board recently awarded to your Company contract for the maintenance of wireless outfits on certain ships which it controlled, but required as a condition certain affidavits that a majority of the shares of your Company were owned by American citizens, which affidavits could not under the present conditions be made.

In a word, we are satisfied and convinced that in order to retain for your Company the proper support and good will of our own Government it is necessary that all participation in its stock, as well as in its operations, on the part of any foreign wireless company must be eliminated. The objections of our Government are founded on such reasons of a patriotic nature as to command our respect and compel our compliance with their wishes.

Having these considerations in mind your officers have lately undertaken to remove the objections of the Government and to do away with the threatened embarrassment of which we have spoken.

Certain long distance and other radio devices and systems have been developed by the General Electric Company, a powerful corporation having assets of nearly $200,000,000, extensive factory facilities and connections with a number of manufacturing companies in foreign countries. Some of these devices and systems promise to be of great value in transoceanic radio communication.

A corporation has been formed called The Radio Corporation of America, which is authorized to issue capital stock as follows:

(a) 5,000,000 shares of preferred stock of the par value of $5.00 per share. This stock is entitled to receive preferred dividends of seven per cent. (7%) per annum and no more. In any distribution of the assets it is entitled to be paid off at par prior to any payment to the common shareholders. The preferred dividends are to be cumulative after the end of the Radio Corporation's fiscal year ending in or with the calendar year 1923.

(b) 5,000,000 shares of common stock without par value.

The preferred stock and the common stock have equal voting power, share for share.

The preferred stock may be retired on any day on which a dividend thereon shall be payable, at the price of $5.50 per share and accrued dividends.

The Radio Corporation has entered into an agreement with the General Electric Company concerning present and future patent rights, the manufacture of patented apparatus and devices exclusively by the General Electric Company for the Radio Corporation and the exclusive right to the Radio Corporation to sell patented radio apparatus and devices of the General Electric Company.

The General Electric Company has appropriated $2,500,000, a portion of which is to be used by the General Electric Company under an arrangement satisfactory to your directors in purchasing the shares of stock in your Company now owned and held by Marconi's Wireless Telegraph Company, Limited, of Great Britain, which shares it will hold, the remaining portion of this sum having been paid in cash to the Radio Corporation or expended or agreed to be expended directly for its benefit.

The General Electric Company has made an agreement with Marconi's Wireless Telegraph Company, Limited, which, if the proposed plan goes through, will enable the Radio Corporation to enter into an agreement with Marconi's Wireless Telegraph Company, Limited, which will greatly increase the powers and privileges of your company outside of the United States and Cuba, and which will provide, among other things, for the formation of a South American company managed and operated by the Radio Corporation, which will own the majority of the stock of various companies which will construct stations in South America for communication with the United States and England, and in due course with other countries.

135,174 shares of the preferred stock and 2,000,000 shares of the common stock of the Radio Corporation have been issued to the General Electric Company The remainder of the shares remain in the treasury.

In addition to the above, the General Electric Company contract with the Radio Corporation to furnish to it certain 200 K. W. High Frequency alternators known as the Alexanderson alternators, with accessories, at an agreed price, to be paid for in preferred stock of the Radio Corporation at par.

In accordance with what is understood to be the wishes of the United States Government, effective means have been used to see to it that the actual control of the Radio Corporation shall at all times be in the hands of loyal American citizens or corporations. It is hoped that it will be possible to accomplish this end and at the same time issue a limited number of shares which can be voted if held by foreigners, the certificates for which are to be known as "foreign share certificates." Efforts will be made with the co-operation of the General Electric Company to supply to your company enough of such foreign share certificates so that all or substantially all of your company's stockholders who are foreigners may receive their stock of the Radio Corporation in such certificates.

It is now proposed to enter into a contract with the Radio Corporation by which your company will sell and convey to the Radio Corporation all its assets and property including cash and securities, except its manufacturing plant at Aldene, New Jersey, and its claims against the United States Government and certain private corporations and firms arising from unlicensed use of the apparatus covered by the patents of the Marconi Company, and will receive two million (2,000,000) shares of the common stock of the Radio Corporation and preferred stock of a par value of $10,000,000 in consideration of the transfer of its assets above set forth and its agreement to transfer to the Radio Corporation the first $500,000 derived by it from the claims above referred to or alternatively to transfer to the Radio Corporation its factory at Aldene, N. J. If the net tangible assets thus transferred, not including the claims or the factory, are not reasonably worth $9,500,000 appraised on a going-concern basis the deficit is to be made up in cash realized on the claims above mentioned as and when the claims are settled, but your Company will not guarantee the claims in any respect and will not be liable for any cash deficit except to the extent indicated.

It is intended (after the proposed plan is approved), to declare a dividend on the shares of your Company of 25c. per share, payable on or about January 2nd, 1920, and a sufficient amount for this purpose will be reserved.

It is also proposed to lease the Aldene factory to the General Electric Company.

This plan, as will be seen, does not involve the sale of the whole assets and property of your Company as an entirety, but does radically change the scope of its operations and transfers the conduct of wireless communication and sale of wireless devices to the new Company. Your directors have thought it wise to call a meeting of the stockholders and take their judgment and advice and obtain their approval of the transaction.

Accordingly, a special meeting of the stockholders of the Marconi Wireless Telegraph Company of America is hereby called to be held at the registered office of the Company, 243 Washington Street, in the City of Jersey City, New Jersey, on the twentieth day of November, 1919, at 12 o'clock noon.

It is contemplated and expected that each stockholder of the Marconi Wireless Telegraph Company of America will have the privilege of exchanging his stock in that Company for an equal amount, par for par, of the preferred stock of the Radio Corporation and in addition shares of the common stock of the new Company equal in number to the number of shares held in the present Company. For illustration, for one share of the par value of $5.00 in the present Company, a shareholder will be entitled to receive preferred stock of the par value of $5.00 in the new Company and one share of common stock in the new Company in addition.

Your directors and officers believe that the carrying out of the plan herein outlined will be of great advantage to the stockholders and will relieve the Company from a seriously embarrassing situation, and they unanimously recommend its approval and adoption. Unless new and unforseen obstacles arise, the New Company under its traffic arrangements with the British Company and others will be enabled shortly after its stations are returned by our Government to start traffic with the British Islands, Norway, France and Japan, and, as soon as the necessary stations are built, to open communication with South America, thus attaining under conditions of financial strength, with a departmental staff of exceptional experience, and ability, the great objective that has always been aimed at, namely, a world-wide system of commercial wireless communication. We believe that such an achievement will not only redound to the advantage of our shareholders, but will be a material and very important benefit to our country.

We, therefore, request stockholders to promptly sign and return to the Secretary in the Woolworth Building, New York City, the accompanying proxy authorizing consent to be given to the sale of the assets of the Company as above outlined and approval of the said plan.

The stock transfer books of your Company will be closed from three P. M. October 31st until ten A. M. December 1st, 1919.

JOHN W. GRIGGS,
President.

233 Broadway, New York, October 22nd, 1919.

A Quenched Spark Gap

THE electrodes of a quenched spark gap usually consist of two plates or rings facing each other in a parallel position and separated a very small distance. Mica discs or rings are inserted between the electrodes in order to keep this distance always constant. It is, however, a very difficult matter to keep the electrodes parallel for a long time, owing to the rise of temperature, which warps them to such an extent that the distance between them is changed in some cases and the quenching effect reduced. If mica rings are inserted between the electrodes the material must be selected with the greatest care, as besides the great electrical stress placed on it, the mica has also to withstand high temperature. In the spark gap shown in figure 1, the electrode surfaces are kept in a position parallel to each other in spite of the rise in temperature. To this end, flanged or cup shaped electrode discs of different diameters are used, the flange of the larger disc encircling the flange of the smaller disc so that the two cylindrical electrode surfaces are separated by a small annular gap. The distance between two such surfaces can easily be kept unaltered providing they have been carefully turned on the lathe. These two discs are separated by an insulating insert i, and are held on an insulating rod w. Any number of these electrodes may be placed on the insulating rod and a compound spark gap formed thereby.

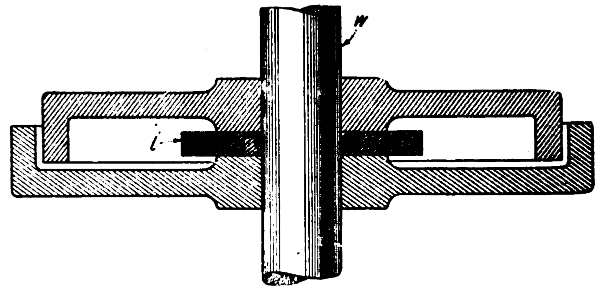


Figure 1—New form of quenched spark gap having the electrode surfaces constantly parallel

Across the Ocean on the NC-4

The Personal Narrative of the Wireless Operator on the Naval Seaplane Which First Spanned the Atlantic in an Historical Air Flight

By Ensign Herbert C. Rodd

PART III

(Continued from September Wireless Age.)

On the terrace of the House of Commons after the luncheon given to the American aviators by the Prince of Wales. The author is in the left center of the picture with fingers locked. Among the notables to be seen are: the Prince of Wales, Lord Reading, Admiral Wemyss. General Seeley and Winston Churchill

THE villagers of Horta, mostly Portuguese peasants, showered flowers and souvenirs upon the crew of the NC-4 when we came ashore; our reception lost nothing in enthusiasm from the fact that ours was the first airship they had ever seen.

But the call of normal things prevailed, and after an appetizing meal served in the captain's cabin aboard the Columbia, we indulged ourselves with about two hours' sleep, to counteract the effects of about thirty-four hours' constant activity from the time we had reached Trepassey. Later, we paid a visit to the village and, as special guests, saw the only "movie" in town.

When we entered our box the orchestra greeted us with "The Star Spangled Banner," and I nearly made a bad bull. Deafness, caused by the constant roar of motors for sixteen hours and signals received through a six-step amplifier, prevented me from recognizing it and I nearly sat down. Then, too, none of the NC-4 crew recognized the Portuguese national air played immediately afterward and the officers of the Columbia had to signal us to rise. After that we jumped whenever the fiddler made a move, during a reception which continued until nearly 2 o'clock the next morning.

Although our craft was ready to leave for Ponta Delgada the next day we waited to get word from our Division Commander aboard the NC-3. This was necessary, since the three NC boats had been commissioned regular ships of the Navy before the start at Rockaway.

On Sunday morning the crew of the NC-1 was brought in by the steamer, Ionia. Standing on the unsteady deck of the Columbia we watched this Greek tramp put in, land the men she had rescued, and then proceed on her way to Gibraltar. She seemed to toss about like a cork in the heavy seas and made us realize what the NC-1 crew had gone through while battling the storm, with their plane going to pieces. The men, glad to be alive, were keenly disappointed over the loss of their plane and the termination of their cherished hope of completing the trans-Atlantic flight.

The welfare of the remaining plane, the NC-3, gave us deep concern at this time and we wondered if she could weather the seas that were running. Even the destroyers were having a rough time of it in their search for her. As the hours slipped by, so did our trust that she would live through it. When Monday morning came, and still no news, we concluded that our brother naval adventurers were lost.

That evening, however, we were overjoyed by a report that the NC-3 had arrived at Ponta Delgada under her own power with the entire crew safe. The dispatch did not state that she was damaged so we expected that the NC-3 and the NC-4 would continue the trans-Atlantic flight together. News that Hawker and Grieve had started from Newfoundland in the Sopwith plane also reached us.

On Tuesday morning, May 20, we made ready to leave Horta for Ponta Delgada. There was nothing to do to the wireless apparatus except to charge the storage battery. The high voltage batteries read 69 volts, the same as at Rockaway. The spark transmitter was in fine condition though the sparking disc and stationary electrode insulator were slightly coated with oxide. This was removed with an oily cloth.

All morning we waited to make the hop. Finally, after five rain squalls had blown over we got started. It was 12:35 o'clock when the NC-4 jumped from the water 20 seconds after the motors were given full throttle. We shipped a little water in the take-off and that caused a leak in the skid-fin antenna insulator, so I could not send until we were high enough to use the trailing antenna. At 1,300 feet I sent a broadcast.

Leaving Horta, after five rain squalls had blown over

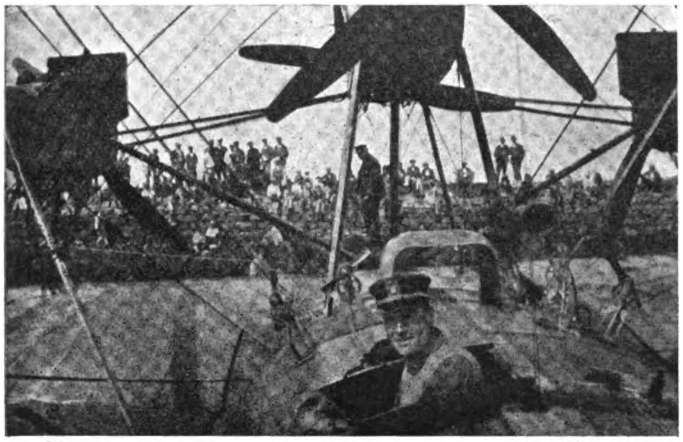
Mt. Pico—Taken from the plane as the storm clouds rolled away

In the harbor at Lisbon where the Order of Tower and Sword was conferred on the crew

Flying high we watched Mt. Pico, the crest of which is 7,000 feet above the sea, and, as though especially for our benefit, the surrounding clouds lifted and we saw for the first time the snow-capped peaks glistening in the sunlight.

A half-hour after the start destroyer No. 24 informed us that she was making heavy black smoke and the Columbia wirelessed that weather conditions were improving along our route. Communication with the Melville at Ponta Delgada was also established a little later and at 1:22 we passed beyond the smoke screen created by destroyer No. 24. A radio compass bearing on destroyer No. 25, fifty miles distant, showed 351 degrees at this time.

Lieutenant Breese created a diversion on the leg to destroyer No. 25 by getting out his shaving kit and shaving himself. The water that he used was badly discolored and I assumed it was hot coffee from a Thermos bottle, and so informed several of the destroyers that were communicating with me. It developed later that the murky mess was hot radiator water.



Waiting for high-tide at Figueira, Portugal, where we were forced to land for repairs and got stuck on a sand bar

When we had been in the air one hour the operator aboard the destroyer Wilkes, which held station No. 4 on the Lisbon leg, informed me that our signals had been fine ever since we left Horta. We passed over station No. 25 soon after this and the station ship Melville at Ponta Delgada came in to inquire what time we expected to arrive. "About 2:20," said our navigator. We were off the harbor at 2:20 and landed at 2:24. As we nosed down, steam could be seen issuing from the whistles of the ships in the harbor, but we could not hear the din until we had landed. It sounded like the celebration of Armistice Day back in the States.

Commander Towers came out in a small boat to greet us and then we learned, for the first time, that the NC-3 was damaged to such an extent that she could not continue the flight. The power plant of the NC-3 was as good as ever. The four Liberty motors operated without any trouble despite the abuse that they had undergone, but the lower wings of the plane had been battered to pieces by the heavy seas when the NC-3 was compelled to descend on account of the fog, and this prevented a continuation of the flight. We learned that these same heavy seas had prevented the plane from rising again and forced them to resort to taxying until they reached Ponta Delgada. It had been no failure of personnel or material, for everything had proceeded according to plan until the fog was encountered. The NC-3 crew looked very haggard and worn, as well they might after their harrowing experience, and we felt a very genuine regret that their misfortune had put them out of the running.

Nearly endless greetings and equally endless photographings awaited us ashore. Admiral Jackson finally came to our rescue and secluded us in his home. We had a week of rain and windy weather at Ponta Delgada but the time passed by rapidly, for the surrounding country was of the greatest interest and there were many receptions and festivities to attend. One very large reception was held at the Governor's Palace, where we met the Mayor, the military authorities and the leading citizens. So generously were the attentions and souvenirs showered upon us that we left there with feelings of awe.

We made a trip of inspection to the plane each morning. Since we were not quartered aboard the station ship Melville I could not supervise the recharging of the batteries for the wireless set, so I sent a message from shore to have it done. When at 5 o'clock the next morning we went aboard the plane I found a new battery which showed a specific gravity of only 1100. A boat was immediately despatched for a new battery which read 1250. Later on I was able to get the old battery back. It registered 1290!

The shelter of the harbor being none too good, we feared some damage to the plane might be caused by a slight change of weather conditions and this gave us so much concern that we had almost decided to attempt to leap the sea wall in order to take off in smooth water in the harbor beyond, when at last a favorable day arrived and we got away in spite of very rough water. The start had been planned for 6 A. M. but because of dirt in the gasoline and carburetor we were delayed about four hours. But as we rose in the air I felt that our troubles were over and the impatience of the past week disappeared.

It was 10:17, Greenwich Mean Time, May 27, when we left Ponta Delgada, on the leg to Lisbon, 786 miles away. The favoring wind was about 23 knots and visibility was good with clouds covering the mountains. Immediately after the start, I inadvertently caused what might have proved a catastrophe to the wireless set, when I made the mistake of plugging in the six-step amplifier tubes on 12 volts and burned them for about a half-hour before discovering it. I felt sure that I had injured them, but upon plugging in 6 volts —the correct voltage—destroyers five stations away were heard loudly. It was evident that the tubes were in good working order so I dispatched some traffic to the destroyer Wilkes for relay to the Melville. A half-hour afterward I sent a message to Admiral Jackson at Ponta Delgada thanking him for his hospitality and stating that we seemed to be on our way. During the next three minutes I requested weather reports and received replies that favorable weather conditions existed along our entire route. Wishes for good luck were extended to us, too, as we passed over No. 1 destroyer on the Lisbon leg. Within the next quarter-hour we passed No. 2 destroyer 10 miles to the southward, sending her a message to that effect, as those on board the vessel did not see us. At this time Destroyer Gamble, No. 6, seemed exceptionally loud for the 200-mile distance between us; destroyer No. 7, 250 miles distant, also called us and advised us that our signals were strong.

We missed station No. 3, the wireless equipment of which did not seem to radiate well on 1,500 meters, so I requested several compass signals from No. 4. At 12:20 he was bearing slightly to the left, ten minutes later he was 20 degrees to the left, and at 12:35, 45 degrees to the left. Commander Read could not figure out what the trouble was, but headed back to our course with the aid of the radio compass, and we passed over Destroyer No. 4 at 12:50, much to the relief of the pilots and the rest of the crew. Later our Navigator discovered that the gimbal rings of our magnetic compass had jumped out of the pivots, probably at the time of our take-off at Ponta Delgada when we bounced on top of several waves. With this trouble rectified the compass functioned properly for the rest of the trip.

At the rate we were flying it appears that radio compass signals were audible at 50 miles, which was the best distance spanned during the trip.

About this time I told Chief Wiseman on the destroyer Wilkes about having worked Cape Race 650 miles. He replied if Cape Race could do it, he could also do it, so we arranged to see how far we could work each other. Since the optimum wave of destroyers is 756 meters, we agreed to use that wave when the 1,500 meter signals became weak. At this time we were flying at an altitude of 1,000 feet and our speed, aided by a westerly wind, was about 88 knots.

At 1:10 Destroyer No. 7 advised that he had heard us when we left Ponta Delgada—a distance of 350 miles. A bearing on No. 6 about this time showed 15 degrees to the left and we passed her at 2:05. Destroyer No. 11 was coming in loud at 300 miles on the run to No. 7, whose radio compass was weak, though we got a bearing from her. It showed 8 degrees to the right, and we passed her at 2:40.

Requests for weather reports were sent to No. 8 and No. 9, to which they replied promptly and at 3 o'clock I exchanged messages between our captain and Captain Simpson of the destroyer Robinson. We passed destroyer No. 8 a little later and I worked No. 4 to test her signals in compliance with Chief Wiseman's wishes.

At 3:30 a weather report was secured from No. 11 in 5 minutes; this time was approximated 15 minutes later when No. 12 replied to a request for a report in 7 minutes. Shortly afterward, 4:18 to be exact, we passed destroyer No. 9. She had been moved 17 miles to the eastward and No. 11 had taken a position 17 miles to the westward of the scheduled points, because destroyer No. 10 was missing, for some unknown reason. At 4:46 I got a weather report from No. 14 and I also worked No. 4 again, both stating that my signals were loud. I called the station ship Shawmut at Lisbon at 5 o'clock, but she did not answer.

Destroyer No. 11 had been audible for 25 minutes on the radio compass, a distance of 40 miles, when we passed her at 5:05. About 15 minutes later I carried out another test with No. 4. She stated she had left her station for Ponta Delgada at 2 o'clock. Her signals were good on 756 meters, but quite weak on 1,500 meters. The Rochester at Lisbon was the next ship to call me with a message from Admiral Plunkett, which read: "Fine work. Come along." Immediately afterward I managed to get a reply from the Shawmut at Lisbon and we exchanged messages. At 6:05 we passed Destroyer No. 12.

The test with Wiseman on the Destroyer Wilkes, No. 4, having lapsed for a time, I worked him again. He said he was only using 4 kw. and that they expected to reach Ponta Delgada about 10 P. M. This indicated that the Wilkes was approximately at station No. 2, making the distance covered by our signals around 520 miles. I promised to call him at 6:30, but being busy with the Rochester for about a half-hour I forgot about the Wilkes and later when I called at 6:47 I heard no reply. I have since learned that Lieut. Sadenwater, using a 950 receiver aboard the Columbia in Horta, copied my messages all the way to Lisbon, and that the chief on Destroyer No. 23, stationed near the Azores, copied us from Trepassey on the Trepassey-Azores leg and also on this leg, Bar Harbor station turned in messages copied from the NC-4 at a distance of 1,400 miles.

The flight thus far exceeded our expectations and now a message came in from the Rochester inquiring as to the time we expected to arrive, to which our navigator answered: "Expect to arrive about 8 o'clock. Please have search-light on water trained into the wind. Shall I land to north or south of Shawmut?" We had passed No. 13 at 6:35 and because No. 14 was bearing to the left about 32 degrees we passed her to the right at about 7:16, shortly afterward sighting the rocky coast of Portugal. Many Portuguese stations were heard, as we approached the coast. Cadiz (EBY) near Gibraltar, especially was very loud and clear.

We approached the Tagus River just as the sun was getting low, and after circling a bit we landed astern of the station ship Shawmut at Lisbon. The time was 8:01 P. M. While landing, I communicated with the Rochester and the Shawmut on the skid-fin antenna without any difficulty. The time for the trip was 9 hours and 42 minutes and the average speed was a little more than 81 knots.

Just after landing at Plymouth. The entire crew at the finish of the epochal flight

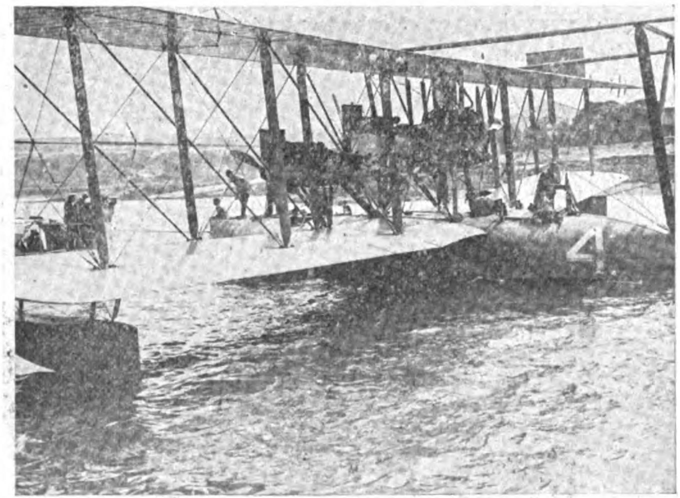
We were taken from the NC-4 immediately and put aboard the Rochester, the flagship of the destroyer force, where we were received by Admiral Plunkett, his officers and men, as well as the American Minister and officials of the Portuguese Government. The Order of the Tower and Sword was conferred upon us on this occasion and we had to pose for "movies" that were taken by searchlight.

At length we were allowed to remove our warm flying clothes and permitted to sit down to a meal. Having taken practically no food since 4 o'clock that morning this part of the reception appealed to us immensely. The crew, a little tired, but in excellent condition, were interested in all the festivities and some went ashore to see the town that night for fear that it would be the only chance, as the NC-4 was in perfect running order and might start the next day. We found Lisbon to be a good-sized city, with many buildings constructed of red and white tile located on an expansive hillside that inspired one with its beauty. If this were not strictly a radio story I might relate many amusing incidents that occurred during our stay. However, it was all very enjoyable and interesting.

No repairs were necessary at Lisbon and on May 30 at 5:29 in the morning we departed. After circling over the harbor we cleared the mainland at 5:55, at which time I let out the trailing antenna. The Shawmut was busy broadcasting until 6:12 when we sent the following message to her: "For American Minister. Request you express to all heartfelt appreciation of Commanding Officer and crew of NC-4 for wonderful welcome (signed) Read."

The destroyers Connor, Rathburne, Woolsey, Yarnell and Tarbell were stationed between Lisbon and Cape Finisterre, using the call letters A, B, C, D and E respectively.

At 6:25, CTV (Monsanto, Portugal) sent this broadcast: "Trans-Atlantic seaplane flight now in progress. Ships are requested to restrict use of radio apparatus to avoid interference with seaplanes." This message did not have the desired effect, for Spanish and Portuguese ships interfered considerably with "QRU?" signals.



NC-4 at Plymouth, showing after cock-pit containing radio equipment. Rodd is hoisting the colors

Weather reports were secured from A, B and C with difficulty and I despatched a message to the Shawmut to request destroyers to listen on 425 meters. Station A was passed at 6:33. Then I was told that a water leak had been discovered in the port motor and it seemed necessary to land for repairs. Shortly afterward I sent B the following: "We may have to land. Stick close on 425 meters for my buzzer modulated set if I send the word 'landing.'" At 7:12 I sent: "We have gas leak on port motor and may land soon." B acknowledged promptly. At 7:15 I reeled in the trailing wire and sent: "Landing, landing, sending on emergency antenna." The NC-4 was headed for the shore near Figueira, Portugal, to find smooth water for the landing, which was made in the Mondego River.

The repairs were quickly made, but in the meantime the tide fell rapidly and small islands appeared here and there, making it unsafe to "take off" until the tide was high again. We went aground on a sand-bar and I called B with the battery set. Hearing no reply I shifted to 756 meters and copied the following, although I missed the call letters: "NC-4 passed station A, but Rathburne (B) has not sighted yet. Sea smooth."

There was nothing to do but wait. Lieut. Stone and Chief Rhoades slept peacefully in the sun on the hull of the plane, while the rest went ashore.

The Shawmut on 756 meters at 8:30 sent the following: "To NC-4. What is your situation? Where are you? Answer via destroyers. Shawmut." Then the following: "Destroyers please listen on 425 meters for message from NC-4." I then called B, but found her sending this message to the Shawmut: "NC-4 not sighted. Am searching to southward of position. Sea smooth, visibility very good." I called B again at the first opening only to hear a destroyer on 756 meters reply: "Proceeding to assistance of NC-4." This reminded me of Chatham when destroyers worked on high wave-lengths and did not listen on 425 meters. The signals were so loud that Commander Read, sitting on a bank 100 feet away, heard them. Ensign Dowd, an aircraft radio officer, divining our situation, sent the following from the Shawmut: "Destroyers please listen on 425 meters for message from NC-4." Destroyer C acknowledged this message, but instead of heeding it called ISW (general call) about two minutes and then sent the Shawmut's message repeating each word and sending very slowly. His intentions were good, but we might have sunk several times during the five minutes he took to do this.

When C finally finished, B called me and asked: "Have you landed?" I answered quickly giving our position, but when I listened A and C were working. Destroyer A said, "NC-4 last seen full speed." B's signals were audible over 100 feet away. He then sent the following to the Shawmut at 9:04: "NC-4 reported leak in gas tank. Would probably land. Am searching to southward of position now. Last signals transmitted by NC-4 were on emergency radio set." This showed that B had heard my message and that the ensuing two hours' delay in rendering assistance could have been avoided if all had been listening instead of sending.

Finally, when things quieted down, I called B again on the battery set and sent: "In Mondego River. Must wait high tide at 2 o'clock. Seaplane O. K. Cannot make Plymouth tonight. Request destroyers keep station. What is best port to north to land within 300 miles? Request report situation Comfran and Plymouth. (signed) Read." B replied that our signals were faint but readable.

It might be noted that the skid-fin antenna was only 70 feet long and stretched about two feet above the top wing. Considering that the telephone set was rated at 5 watts, the distance which this message traveled—about 25 miles—is quite remarkable.

At 10:30 two destroyers arrived, anchoring off the mouth of the Mondego River, and Lieut. Commander Geer phoned that Commander Symington was on his way to us in a boat. When he arrived the details for the remainder of the trip were arranged. It was decided to stop at Ferrol Harbor, Spain, before dark and continue the flight to Plymouth the next day. At 2:14 the following by Commander Read was sent from B to C, having been semaphored to the Rathburne, anchored off the mouth of the river: "To Comfran, Brest and Simsadus, London, from NC-4. Request destroyer of coast division nearest Ferrol Harbor proceed there immediately anchor in position when seaplane can secure astern and act as tender for NC-4. Expect leave Figueira one thirty GMT and stay Ferrol tonight leaving for Plymouth tomorrow morning at eight weather permitting. Read." "Comfran" is the code word for Commander of Naval Forces in France and "Simsadus" stands for Admiral Sims.

We left the water at Figueira at 1:38, getting off very easily and with a slight favoring wind and fine weather set out for Ferrol. A few rain squalls were dodged by hugging the coast where the air was clear and the scenery more enjoyable. The Liberty motors were turning over so good that the estimated time for the trip was beaten by 15 minutes. The wireless apparatus was working fine, as usual, and my head phones were buzzing continually from the increased air talk.

At 2:51 I received the following from station E: "Tarbell will arrive Ferroll Bay 4:30 P. M." Immediately after that a delayed message from station D, relayed from the Rochester, came in. It read: "Best place north Mondego River is Ferrol, and second, Vigo."

Passing station D at 3:10 we told the Tarbell that we would arrive at Ferrol about 5 o'clock. Greetings were exchanged with Spanish stations at Oporto and Cape Finisterre about 4:15 and we also received the following from station No. 1: "Harding will act as mooring ship at Ferrol. Will anchor in inner harbor on arrival unless you wish me to meet you outside." The operator added that he had heard us 450 miles. Station E sent: "Will be outside making big smoke." As we came within range the Spanish station at Ferrol inquired: "Hydroaeroplaniz Norte Americano," to which I replied that we were.

At 4:45 the outskirts of Ferrol were reached and the NC-4 began to spiral to the landing, so I reeled in the trailing wire. The landing was made two minutes later. People flocked by the thousands to the docks and sea-walls to view us.

Immediate attention was required by the many small sail boats that swarmed out; these gave us much concern because of the danger of tearing the fabric of the ailerons, as they insisted on sailing underneath them. We endeavored to wave them off, but it was futile. At last, much to our relief, a Spanish admiral appeared on the scene and, uttering a few excited phrases, got them to disperse a reasonable distance.

The harbor afforded excellent shelter for the plane. The Harding came in from sea about 15 minutes later to act as a mooring ship, but the NC-4 required very little attention. I did not even charge the battery, though it had been used considerably at Figueira. Ferrol boasts of the largest navy yard in Spain and the friendly and courteous welcome by the naval officers was on a scale to comport with it.

We left this Spanish port on the following morning, May 31, at 6:27 o'clock. The NC-4 climbed so rapidly that I was working on the trailing wire within six minutes and heard the Harding sending our time of departure to station No. 2 for relay to Comfran, Brest, and Admiral Plunkett at Plymouth. At 6:37 I heard No. 4 sending the message to the Rochester. Stations Nos. 2, 3 and 4 replied to my requests for weather reports, stating that visibility was very good at No. 2, good at No. 3 and fair at No. 4. Station No. 5 (the Biddle) came in loud on his compass schedule, but was two minutes ahead of time, so I called him and corrected his time. At this stage of the flight rain was encountered and the weather became thick, causing reduced visibility and requiring frequent changes of course.

I asked No. 3 for compass signals. The reply gave a bearing 35 degrees to the left and 17 minutes later it was 49 degrees to the right. Thus it was apparent that we had passed No. 3 without seeing her and that the bearing was reciprocal. We were uncertain as to our course so the Navigator steered from bearings obtained by the radio compass. At 8:30 No. 3 was 45 degrees to the right and getting fainter. No. 4 was 20 degrees to the left, changing to 40 degrees left 18 minutes later. This proved that we were too far to the East for the bearings, or that No. 3 was a stern bearing.

At 9:03 No. 4 said she had sighted us and we flew over her three minutes later, somewhat to the relief of our navigator who was having difficulty in keeping to our course. Up to this time I had heard nothing from Destroyer No. 6, the Stockton, stationed near Plymouth; so I asked No. 5 about her. He had no definite answer, but No. 4 volunteered the information that the Stockton was at her station although possibly she was not sending. The Rochester, 300 miles away, surprised me with her signal intensity from Plymouth. A message from her read: "Desirable NC-4 land inside breakwater near Rochester, then taxi to mooring in Cattewater west of Mount Batten. British plane will probably lead you to mooring. Aroostook boat at mooring." She also sent this weather report: "Weather in Plymouth fine. Light northeasterly breezes, clear overhead, but slightly hazy around horizon. Apparently splendid flying weather. Stockton is in position."

We missed No. 5 station entirely and No. 6 asked for the time of arrival at her station. I replied that we had probably passed No. 5 about 10 A. M. and that we were going to fly over Brest. An attempt to get a time tick from the Eiffel Tower failed, because I just missed the schedule and Nauen, sending at noon on 4,000 meters, was beyond the range of my receiver.

A part of the reception in England which the author terms "a fitting climax to the whole trip"

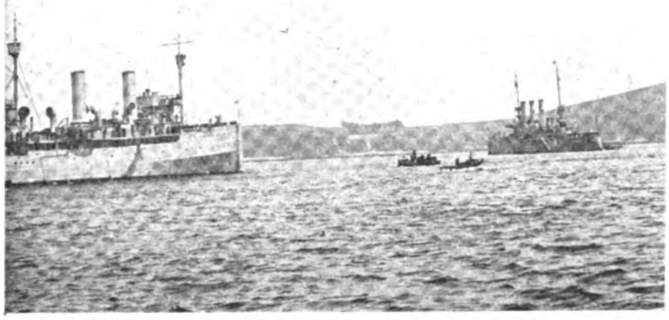
The George Washington at Brest called us about 10:50 and I received on the skid-fin antenna because we were flying low. I surprised the operator by telling him that I had copied his messages when leaving Newfoundland and only convinced him that it was true when I repeated the text.

Brest station came in with a "Bon voyage bon jour." Not knowing much French I had to limit my reply to: "Merci."

When, at 11:15, we sighted a point south of Brest and turned off our course to get a look at the harbor, I sent the following: "To Comfran-Brest: Greetings from NC-4. I am sorry we cannot stop. (signed) Read." Brest replied: "To NC-4: Congratulations on your magnificent feats. Sorry you cannot stop and let us entertain you. Good luck. (signed) Halstead." Brest harbor seemed just full of American ships and was the most typical American sight on our trip. It seemed quite like a port of our own.

Passing over Brest we flew very low to secure better visibility, and leaving France behind, ran into an increasing head wind and thick haze. This cleared slightly when we reached the middle of the Channel but not until we had sighted Plymouth, about an hour later, were we high enough at any time to let out the trailing wire, so communication was maintained through the U. S. S. Hannibal at anchor in Brest Harbor.

About 12 o'clock destroyer No. 6 sent weather reports, saying the sun was shining and visibility was seven miles. I told her that, flying low in fog, we were using the small antenna; she replied that our signals, though faint, were getting louder. A little later No. 6 added that our signals were good and that she was making heavy black smoke so that we could locate her. Her bearing then was 50 degrees to the right and three minutes later it was 55 degrees to the right, or reciprocal. Upon inquiring if our signals were louder she replied: "You seem about the same."


The NC-4 beginning the spiral to the waters of Plymouth harbor and the end of the first trans-Atlantic flight

I don't know how the Navigator felt at this time but I doubted the correctness of our course to Plymouth and therefore took every opportunity of locating our position by radio. At 12:41 No. 6 transmitted the information that visibility was eight miles and our signals were weaker. I replied that I thought we had passed to the eastward of her. Then, looking out of the hatch, I saw a merchant ship and I hoped we could get our position through her, so I sent the International Abbreviation for "What ship is that?" and "What is your position?" Probably the operator was out on deck watching us, for no answer was received on 600 meters. Destroyer No. 6, however, came in with: "There are two sailing vessels about four miles apart, bearing 150 degrees true, eight miles from Stockton." But we did not see them.

Having visions of missing Plymouth I asked the navigator if it was possible to climb to 400 feet so that I could call Plymouth station for compass signals on the trailing antenna. I thought that shore station bearings, being more accurate, would help us to find the harbor. We began to climb, but had to come down again because of very thick weather at 300 feet. The Rochester at Plymouth then called and said that our signals were getting louder. Her signals were good, but reception on the skid-fin antenna was not as good as on the trailing antenna four hours before, when we were only half way across the Bay of Biscay. Plymouth seemed to be further away than it really was. After being accustomed to the signal strength obtained from the trailing antenna the decrease of signal intensity on the skid-fin antenna was very confusing.

The Aroostook now came in with best wishes and while I was listening in the NC-4 began to climb. This permitted the use of the trailing wire again.

Land was sighted at 1:15.

Destroyer No. 6 called and said that the visibility was ten miles and the sky was clear, to which I replied that we had sighted land and were all right.

We found ourselves headed directly for Plymouth harbor. This was very good navigation on the part of Lieut. Commander Read, for the wind had shifted several times during the flight across the Channel and the pilots, who had frequently been ordered to change the course, did not think that we would land exactly at Plymouth.

We climbed to 3,500 feet and circling for position landed inside the Cattewater at Plymouth at 1:26, thus ending the first trans-Atlantic flight and achieving the hitherto impossible in human endeavor.

Two British planes sent out to meet us came in about ten minutes after we landed, having missed us on account of the fog. They were equipped with 1,600 meter continuous wave transmitters, but since I knew nothing about it at the time I did not tune to receive that wave-length.

The reception by the officials made a fitting climax to the entire trip.

We were again taken aboard the Rochester, where the usual motion pictures were taken, but, unlike our experienc at Lisbon, we were promptly fed, being cautioned to allow for the public banquet to be given at the Grand Hotel by the Royal Air Force. Our stay on shore lasted eight days.

In London we were received splendidly everywhere, one occasion which stands out being a luncheon given by the Prince of Wales at the House of Commons. I sat next to Commander Grieve, the companion of Hawker in his attempted trans-Atlantic flight, and upon inquiry learned that their Sopwith plane had been equipped with a radio set, but the apparatus had failed to work satisfactorily. Admiral Wemyss was intensely interested and questioned me closely on the NC-4's installation. He seemed to have an excellent knowledge of radio. While in London I called at the Marconi House just in time to verify a communication that General Manager Bradfield had received from the Cape Race station concerning the distance the NC-4 had worked.

Paris and the famous Eiffel Tower then received our attention, and shortly before we prepared to leave for the good old U. S. A. we were permitted to visit the Battle-Front in France, spending much time at Chateau Thierry and Belleau Woods. Those two places seem very close to Americans.

Summarizing my observations made during the entire flight the things worthy of note are about as follows:

The health of the crew was better at the finish than at the start of the flight. The performance of the Liberty motors, especially the motor installed at Trepassey without a test, was marvelous. In fact the whole plane was in excellent condition upon our arrival at Plymouth and we regretted to see her torn down for shipment to the United States. We preferred flying to London and Paris instead of traveling by rail and steamer.

The radiation on the skid-fin antenna changed slightly during the flight across the Channel, but it was kept to 3 amperes by adjusting the variometer from time to time. This variation was no doubt caused by the varying quantity of moisture in the air at different times and at different altitudes. Radiation on the trailing wire averaged 3.3 amperes throughout the flight and the transmitter, running 54 hours without oiling, functioned perfectly. Judging by ear, the frequency of the generator was never quite up to 500 cycles, due no doubt to being mounted too near the deck, which prevented the proper rush of air from reaching it except when the center tractor engine was running. An improvement would be to mount the generator on an upper wing, out of the slip stream of the propellers, so that in a glide with dead motors signals could be sent. The present position of the generator propeller is in the path of all traffic over the hull when the plane is at rest, and in flight the propeller is apt to be damaged by things blown against it while traveling at 5,000 revolutions per minute.

No adjustments or repairs of any kind were required on the oil field-switch, sending key and antenna switch. The 6-tube amplifier also worked perfectly. Four extra tubes were never used and the six used were never transposed to secure a better combination even after 12 volts had been applied to the filaments for a half-hour by mistake. The only tendency of the amplifier to oscillate was at slightly above 1,500 meters.

A voltmeter was carried on the flight and readings at Plymouth showed the plate battery up to 68½ volts after nearly 100 hours' usage—a loss of only ½ volt since leaving Rockaway. The value of immersing the cells in paraffine is very evident, for ordinary batteries would not have stood up through the rain and fog encountered during the flight. The cut-down SE-950 receiver gave no trouble. Tight coupling was generally used because interference was seldom experienced. I noticed that maximum inductance and minimum capacity gave the sharpest tuning possible, and also the best audibilities.

It might be stated that the amount of amplification necessary to overcome the mechanical noise of the engines has been reached with the 6-valve amplifier, and although the signal audibility is increased by increasing the pressure of the phones no better readability is obtained.

The induction was much worse when using the compass coils than on the antenna. This, coupled with the fact that the signal intensity without any induction interference is much less than on an antenna, explains why the ratio of audibility on the same destroyer was about one to eight. Many readings were taken on the "A" coil only, because of the great increase in induction experienced when the "B" coil was thrown in. With the single coil it is possible to read within 5 to 10 degrees using the maximum method and taking the mean of the points when signals fade out, after rotating the coil either way from the maximum point.

A remarkable feature was that not a trailing wire or "fish" was lost and the tension of the skid-fin antenna developed no sag during the trip from Rockaway to Plymouth. All the insulators were leak proof except the lead-in from the skid-fin antenna, which, after having all the exposed surfaces rubber-taped at Ponta Delgada, functioned properly when the power transmitter was used.

Mention may be made of the desirability of having the wireless operator located so as to secure outside visibility with relation to the plane or else placed in close proximity to the navigator. It is hoped that the design of future flying boats will include this improvement.

The flight demonstrated the urgent necessity of developing the use of the radio compass to a much higher degree of efficiency and also made apparent the need of an emergency set employing a broad wave in place of the very sharp wave emitted by the continuous wave transmitter.

The use of a telautograph is contemplated for standard equipment in large seaplanes. It has the advantage of being both a communicating and recording device and requires a radio helmet only for the wireless operator instead of one for each of the entire crew.

In conclusion, I want to thank all the destroyer operators who stuck to the job so faithfully and gave us such excellent service. Since our flight, nearly every day has brought information that some ship or station heard us at greater distances than has been recorded in this story.

Weagant "Group Frequency" Circuit

ANOTHER circuit devised by Mr. R. A. Weagant for the detection and amplification of continuous and damped oscillations is shown in figure 1.

The aerial is earthed in the usual manner. Coupled to the aerial either directly or inductively is a secondary circuit which includes an inductance being in series with it, a variable condenser which is connected to the grid of a three-element valve. The plate of the valve is connected to a local circuit, which includes a telephone shunted around which is a variable condenser. In series with the telephone is placed a relatively large resistance shunted by a condenser in series in an inductance. The resistance is connected in series with the high potential battery, which in turn is connected to the negative side of the filament. The filament may or may not be connected to the earth. Connected across the local circuit from the plate to the filament is a second condenser in series with an inductance. Both the condenser and the inductance are adjustable so that they may be varied to secure the best effects. The last mentioned inductance is used when receiving continuous oscillations. It is not essential for damped wave reception except when the damped wave signals are very weak.

The condenser and inductance in shunt to the resistance permit of tuning the telephone circuit, which includes the telephone itself, to the group frequency of the incoming signal so that in the event of the apparatus being used to receive damped oscillations the effects produced by the groups of oscillations are very much magnified.

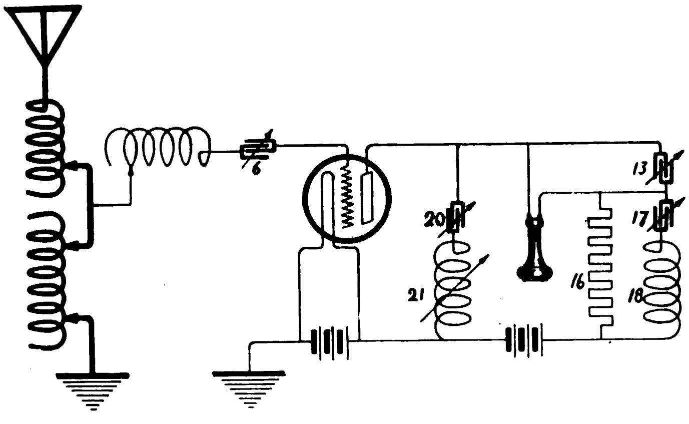


Figure 1—Circuit for detection and amplification of continuous and damped oscillations

In using the apparatus to receive continuous oscillations the inductance in the telephone circuit may be dispensed with.

Figure 2 shows a modification of the arrangement, which consists in using a closed secondary circuit, which includes the inductance 5 and capacity 6 instead

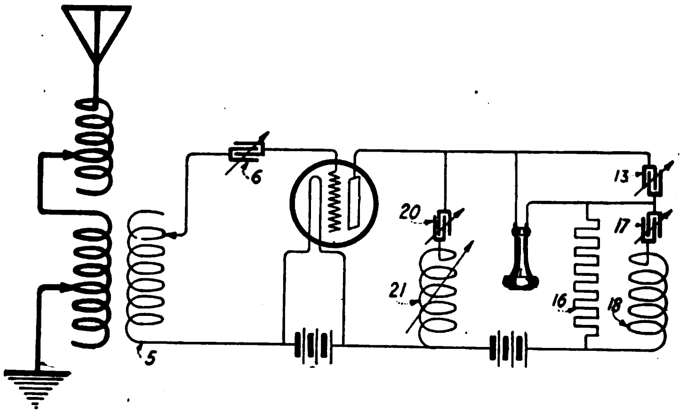


Figure 2—Modified group frequency circuit

of the open circuit shown in figure 1. It is also to be noted that the filament is ungrounded in figure 2. The operation of either arrangement is, however, essentially the same. The method of operation is somewhat as follows. The filament is first adjusted to incandescence. The potential of the high voltage battery is adjusted to a point so that the incoming signals give a maximum response. The resistance 16, the inductance 18, the condenser 17, the condenser 13, the condenser 20, and the inductance 21, are separately varied until the maximum effect of each is obtained. The usual adjustments of the aerial circuit and of the inductance 5 and condenser 6 are made in conjunction with the above mentioned adjustment of the local circuit. The adjustment just described is ordinarily used when damped oscillations are to be received. When continuous oscillations are to be received, it is preferable to adjust the potential of the high voltage battery to such a point that there is heard in the telephone receiver a high pitched note. This adjustment is generally to a higher voltage than that ordinarily employed for receiving damped oscillations with detectors of this type. For example, potentials as high as 100 volts and a resistance of 75,000 ohms has been used in practice. Having obtained this high note in the telephone receiver, the capacity of condenser 13 is reduced until this note is no longer heard or is very slight. The same result may be obtained by the adjustment of condenser 20 instead of condenser 13 or by a combined adjustment of the two.

Stabilizing the Energy Output of Transmitters

GUSTAV REUTHE has worked up a method of stabilizing the energy output of a radio transmitter which utilizes frequency changers by which the fundamental frequency of the primary source of alternating current energy is multiplied to obtain the frequency required for radiation.

The novelty of the means lies in suitably controlling the electrical characteristics of the several circuits of which such transmitter arrangements are composed, and in so far as these circuits constitute oscillating systems, in such a way that they are brought out of resonance with the fundamental frequency of the primary alternating current generator, or an integral multiple thereof, to a certain degree.

When transmitter arrangements of this character are operated, certain difficulties are encountered in maintaining a steady energy output and at certain frequencies and under certain load conditions, the whole system becomes unstable. In such a condition, a very slight variation of operating conditions such as for instance the variation of the speed of the generator or of the generator potential, or of the load, is sufficient to vary the current in the generator circuit in leaps so that it becomes very difficult to maintain a steady output, thus rendering operation difficult and sometimes impossible. Besides, the excess of potential, which might result from such leaps, is apt to endanger the entire installation. This danger is particularly great in case the entire system is in resonance.

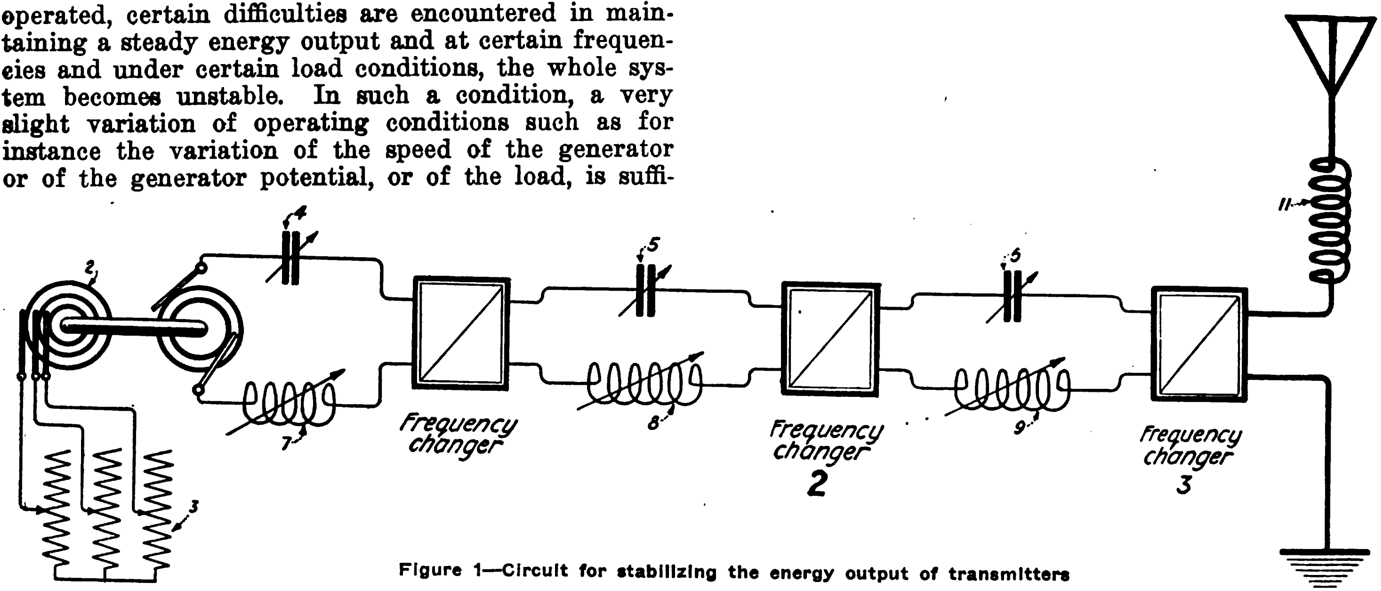


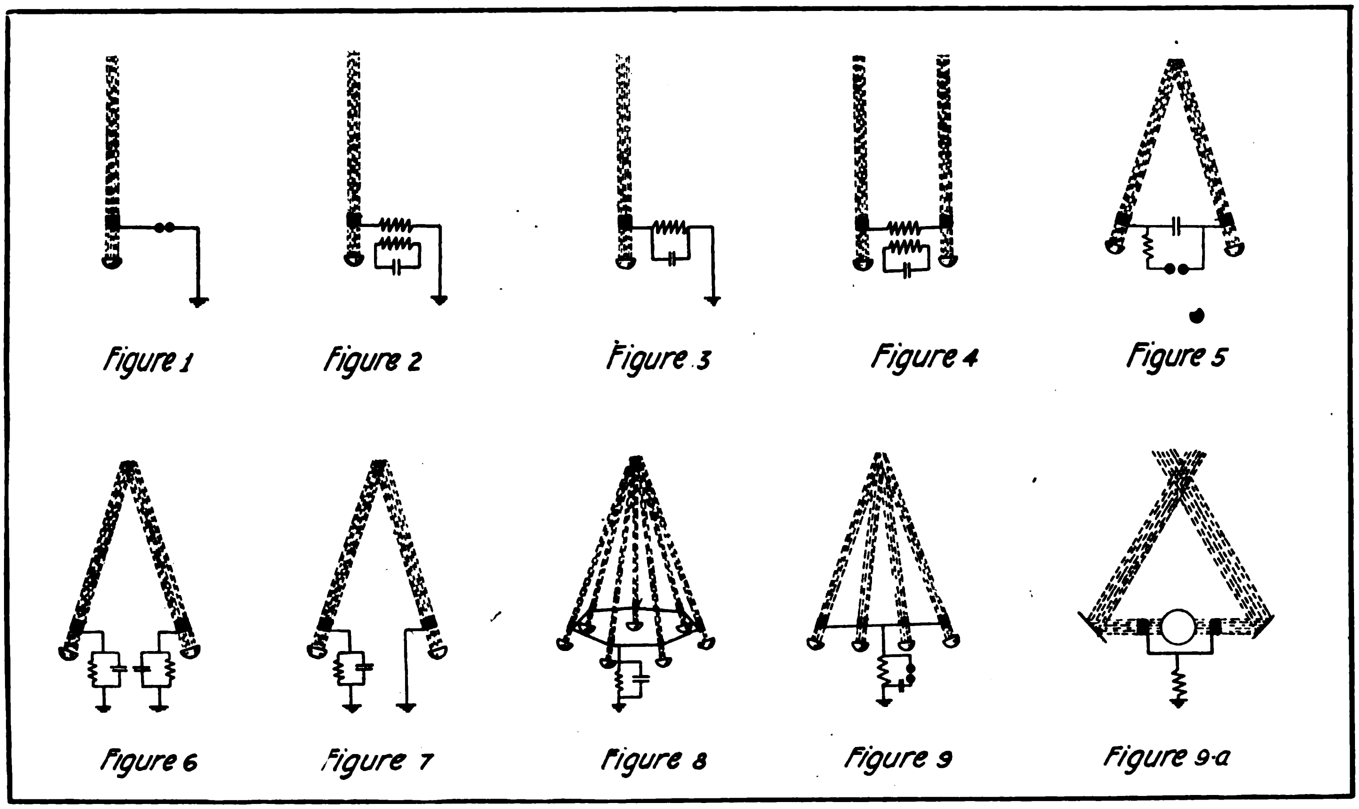
Figure 1—Circuit for stabilizing the energy output of transmitters

In the endeavor to overcome difficulties of this character, Mr. Reuthe detunes the generator circuit with the generator frequency, and the intermediate circuits are detuned with the multiple of the generator frequency supplied to them by their particular frequency changer. He states that especially favorable results are obtained when the tuning means (capacity and inductance) of the generator circuit and of the intermediate circuits are chosen larger than those values corresponding with the exact resonance. Very favorable results are always obtained in connection with the above mentioned scheme when the antenna circuit is somewhat out of resonance with the multiple of the generator frequency supplied to it. In this case, however, the detuning must be such that the constants which determine the resonance of the antenna circuit are smaller than the values corresponding with the resonant condition.

In connection with this expedient, a regulator is also provided which regulates the speed of the prime mover so that if the prime mover exceeds a certain speed the output of the engine or motor is decreased.

A High Antenna Without High Masts

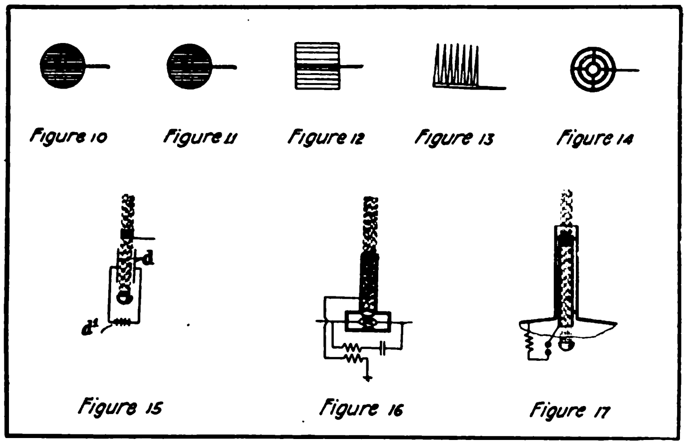
RADIO men are more or less familiar with the effects which strong ionization in the upper atmosphere levels has upon the electrical waves used in wireless telegraphy. In studying the spectrum, we find that there is a decided absence of the shorter wavelengths. It has been shown by at least two scientists that the light which reaches the surface of the earth from the sun contains no wavelength shorter than about 2950 Angstrom units. It would be unreasonable to assume, in view of what we know, that no shorter wavelengths leave the sun and stars, and since it has been proven that an upper ionized layer of atmosphere exists, we have come to the belief that the light of the shorter wavelengths is absorbed prior to the time that it reaches the earth. The atmosphere immediately surrounding the earth then is not ionized, or, only very slightly so due perhaps to the radio-active matter in the sea or earth or to photo-electric action on dust particles.



Various arrangements of aerials

Ionization of gases is proven by the acquisition of electric conductivity on the part of the gas. An un-ionized gas is a perfect non-conductor. Advantage has been taken of this characteristic by John Hettinger of London, who has taken out a patent wherein he proposes to substitute conducting ionized beams, such as a search-light beam of ultra-violet rays produced by means of a suitable electric arc or mercury vapor lamp, for the wires of an antenna for transmission or reception of radio telegraphic and radio telephonic signals. According to the invention, a portion of the atmosphere is continuously ionized along a beam so as to render it more conductive than the remaining portion and a good electrical connection is established between the beam and the metallic portion of the electric circuit in which the beam is substituted for the long conductor. In view of the fact that the air along the beam is not enclosed but is in actual contact with the remaining part of the atmosphere there is a certain amount of diffusion, with the result that the surrounding atmosphere in the immediate neighborhood of the beam is also rendered conductive to a less extent.

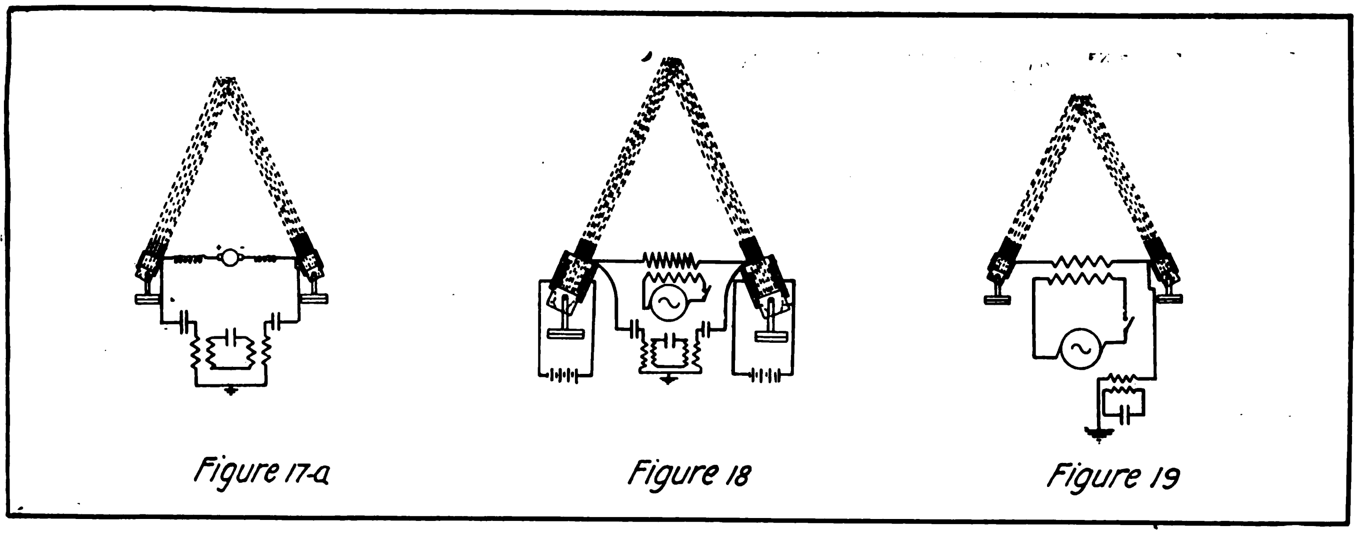
The conductivity decreasing continuously and quickly along circles concentric with the beam and also gradually decreasing from its electrical connection in the direction of the beam facing away from its source. Further, owing to the fact that the air is free to move about, ionized particles of air will be shifted from the position they occupy in the track of the beam so that the actual form of the conductive zone will be altered to a certain extent at various points. The effect of these various conditions is that although ionization is actually maintained along the beam, the beam conductor is not supposed to have the actual form of the beam but a form depending upon circumstances above referred to, the line of comparatively strongest conductivity being in the center of the beam with small deviations therefrom, as in the case of movements of air. When used for signaling purposes this beam conductor may be compared to an elevated conductor of large surface in electrical connection with a metallic circuit, the other end of which is connected to earth. The potential imparted to the metallic portion of the circuit tries to equalize itself along the beam conductor and the entire system thus absorbs large amounts of energy as compared with the energy that could be imparted to the system without the ionized beam. In the latter case, all the lines of electrical force would be bent toward the earth immediately after leaving the other end of the metallic circuit. Where the beam is used, however, a current will flow along the lines of least resistance, viz: Upward within the beam and immediately around it and more particularly along its center and there will be lines of force which will start bending downward toward the earth at a much higher point than would be the case were the beam not used. While the amount of current actually flowing through the beam may be small and decreasing continuously toward the upper end of the beam it is to be remembered that this is not material in the case of an aerial, it being known that the current flowing through the aerial and more particularly through the upper part thereof may be small as long as the potential is high in the upper part and the current large at the point where it is connected to the earth. The electrical connection of the ionized beam with a point of high potential and the absorption of great energy by such a beam insures the fulfillment of these conditions. The accompanying drawings illustrate diagrammatically various arrangements and details for carrying the invention into effect. Figures 1, 2, 3, 4, 5, 6, 7, 8, 9 and 9A illustrate various arrangements of aerials. Connections to the beam are made with devices as shown diagrammatically in figures 10, 11, 12, 13 and 14.



Various methods of producing beams and the types of connections

It is known that when certain metals are charged, more particularly with negative electricity, they have the property of becoming discharged under the action of light and it has been determined that this discharge is due to ultra-violet and other rays and would be dependent upon the state of the surface of the metal. This property of certain metals is usually referred to as photo-electric effect. Since a small length of the beam lies between the electrical connection and the source of the beam use may be made of the photo-electric property—possessed by certain metals and not by other metals—to prevent a discharge of electricity from the electrical connection toward the source of the beam, or to reduce it as much as possible and at the same time assist the discharge from the electrical connection in a direction away from the source of the beam. With this object in view the photo-electric effect, above referred to, has to be assisted in every respect on the surface of the connection facing away from the source of the beam, while the effect has to be prevented from taking place—or reduced as much as possible—on the surface facing the source of the beam. For instance, the surface of the gauzes or perforated plates facing away from the source may be highly polished while the opposite surface may be covered with a material which is not transparent with respect to ultra-violet rays. The same object may be obtained by using for this connector metal which is not very sensitive with regard to the photo-electric phenomenon, such as copper. This copper is provided, on the surface facing away from the source, with a covering of metal which is very sensitive with respect to the photo-electric phenomenon, such as rubidium or an alloy of potasium or sodium. The discharge of electricity from the metallic connection toward the source of the beam may also be prevented or greatly diminished by removing or greatly reducing the conductivity of the beam between its source and the metallic connection, causing a direct or alternating current to flow across the beam in that part lying between the source and the metallic connection. This flow of current may be produced by means of an electric field as shown in figure 15 and in figure 25. The two plates d of a condenser being connected to the two poles or source of d of constant potential may be replaced by an alternating current supply of low or high frequency which may belong to the transmitting system.

For the production of the beam use may be made of an ordinary searchlight in which an arc lamp or mercury vapor lamp is employed, care being taken to prevent the absorption of the ultra-violet rays by substituting quartz for all transparent parts usually employed in searchlights.



Method of superposing high-frequency currents upon a low alternating electric field or upon a continuous electric field of high potential

The spark or arc producing the oscillations may also be employed for producing the beam. In figure 16, illustrating such an arrangement, a spark gap is enclosed in a cylinder of insulating material having an extension which is open at its outer end to allow the passage of the beam to the exterior of the electrical connection which is effected by a series of pointed metal pieces carried on a support electrically connected with the secondary of an oscillatory transformer which is earthed. Quartz may also be arranged in the back of the beam.

The high frequency currents or impulses supplied to the transmitting beam aerial or collected by the receiving beam aerial may be super-posed upon an alternating electric field of low frequency or upon a continuous electric field of high potential. This is illustrated in figure 17 in connection with a continuous electric field, and in figure 18 and figure 19 in connection with an alternating electric field. Referring to figures 17 and 18, the continuous or alternating field of low frequency is set up by connecting the two poles of a high voltage continuous current machine through inductive resistances, or the two terminals of the secondary of an ordinary transformer (not a high frequency oscillation transformer) to two electrical beam connections, one of which is directly connected to the oscillatory system while the other connection is not directly connected to the oscillatory system, and is placed in an ionized beam arranged to intersect the beam in which the beam connection, first referred to, is placed.

In the application of the invention to wireless signaling to and from aircraft use is preferably made on the aircraft of one ionized beam aerial directed downward so that it may strike the earth, a telegraph wire, a railroad track, or other conductors and of another ionized beam aerial which is substantially parallel to the earth, thereby forming a directive aerial. See figure 20.

The aerial may be used in connection with any wireless aerial of known construction, for example, it may be movably connected with the top end of the usual elevated aerial thereby forming a directive aerial of the horizontal type. Figure 21 illustrates such an arrangement in which the source of the beam together with the electrical beam connection, is mounted on and insulated from the casing of the arc and is electrically connected with the top of the aerial. It is mounted on a high support in the usual manner so that it may be turned in a horizontal plane as well as in a vertical plane.

Attempts have been made heretofore to transmit wireless signals over long distance by means of low horizontal aerials, but such attempts have not led to any practical results. Transmission over long distances may now be accomplished by combining low horizontal aerials with the ionized beam aerial, and leading the free end of the horizontal metallic aerial into the ionized beam by means of a beam connection, the source of the beam receiving its energy from a source of current G or by arranging the metallic aerial in a plane of ultra-violet rays directed upward. See figure 22. The latter arrangement is preferably carried out as shown in figures 23 and 24, by using as the metallic horizontal aerial, a long strip E of zinc or other metal which is sensitive with regard to the photo-electric phenomenon and is bent to form a trough, the ionized aerial being produced by several mercury vapor lamps of tubular shape supported in the concave part of the metallic trough and being directed upward in a plane containing the metallic aerial, the mercury vapor lamps receiving the current from the source of energy G.

This invention is also well adapted for use on submarines and figure 25 illustrates a transmitting arrangement used in connection therewith. The electrical connection is attached to the upper part of a metal tube which is arranged within a periscope and forms with the latter a condenser included in an oscillatory circuit. The system is earthed through the body of the submarine. The periscope mirror (not shown), which may be used to reflect the beam in any desired direction, must be made of metal or the glass used in ordinary mirrors must be replaced by quartz. The receiving apparatus may be connected up to the beam aerial in a similar manner.

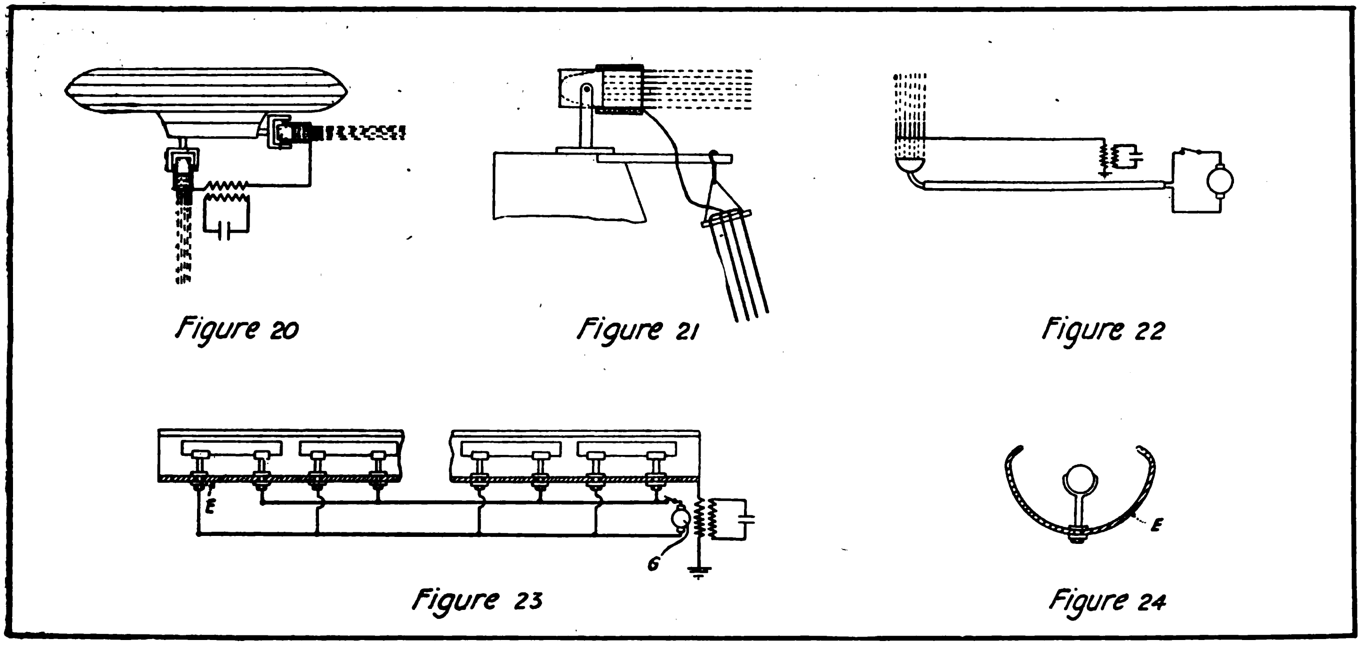


Figure 20 Figure 21 Figure 22

Figure 23 Figure 24

Arrangements to realize the advantages secured through the use of beam aerials

The Effect of Direct Connection of Plate Circuit With the Antenna

THE novel feature of the wireless signaling system devised by W. C. White lies in the means which he takes in getting around certain difficulties encountered in the usual arrangements, by including the plate circuit inductance directly in the antenna circuit and thus impress the alternate component of the plate current upon the antenna, thereby avoiding the necessity of an inductive coupling between the plate circuit and antenna and the use of a separate coil. In his practical application however, it is found that the source of potential used for heating the filament together with the auxiliary apparatus used to control the heating current, instead of being at a fixed low potential with respect to the earth as in the ordinary arrangement, is at a potential which alternately varies at the frequency generated between positive and negative values with respect to the earth and that this potential may rise to such a high value that it becomes inconvenient to insulate from the earth the source which furnishes the heating current. In order to get around the difficulty, the plate circuit inductance has been divided into two parts and the parts arranged in such a way that two parallel paths for the high frequency plate current are provided. One of these inductances is included directly in the antenna circuit and the second inductance is so closely coupled to the first that for all practical purposes, it may be considered as being directly in the antenna circuit. The source of current for heating the filament is connected to the ends of those inductances, which are always at a low potential with respect to the earth, in such a way that the heating current always flows through the two inductances in series. As a result the source which furnishes the heating current, as well as the regulating apparatus, will always be at a low potential with respect to the earth.

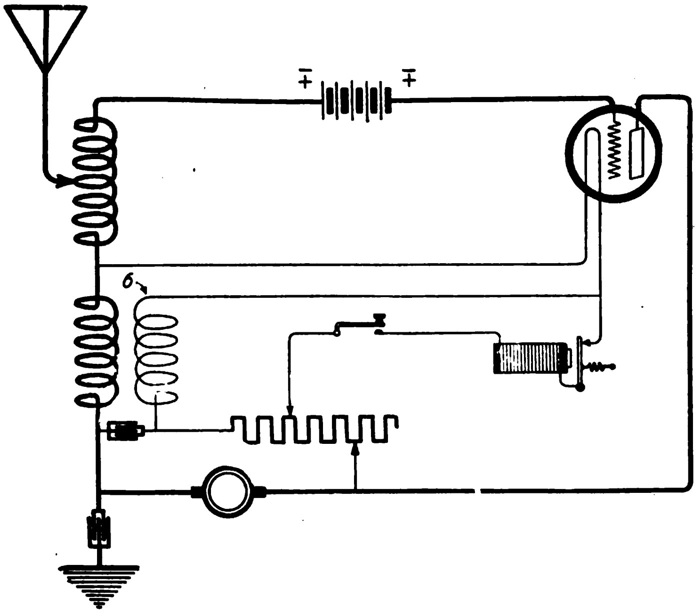


Figure 1—Diagram showing plate circuit hooked up to the antenna

A further object of his device is to provide a simple and effective means for automatically breaking up the oscillations which may be generated by the arrangement so that audio frequency telegraphic signals may be formed. With reference to the diagram, this is accomplished in figure 1 by arranging a buzzer so that inductance 6 is short circuited at regular intervals, thereby interrupting the production of the oscillations. The arrangement shown in figure 2 differs from that shown in figure 1 merely in the arrangement of the auxiliary circuit for controlling the oscillations. In figure 2 the grid circuit is so arranged that the device is normally inoperative for producing oscillations. When the key is depressed the grid circuit is closed through the key and the contact of the buzzer and oscillations are produced. At the same time the buzzer coil is energized and the buzzer contact broken, oscillations thereby being interrupted.

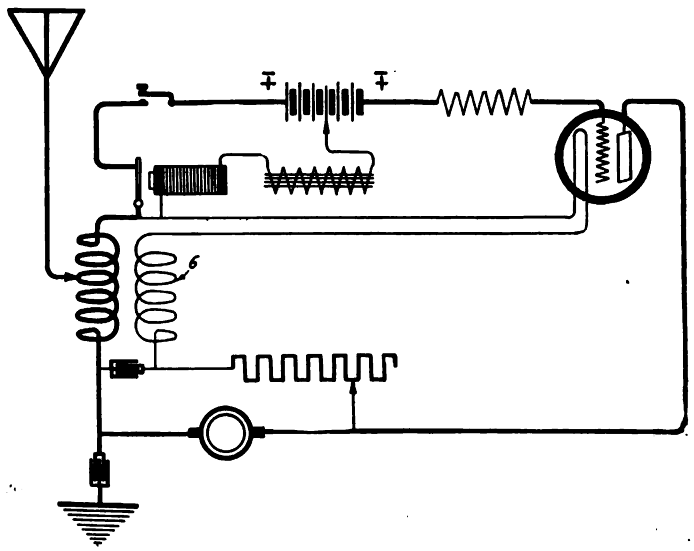


Figure 2—A modification showing the grid circuit arranged to normally prevent operation

Kolster's Direction Finder

A CIRCUIT diagram of Frederick A. Kolster's direction finder is shown in figure 1. It is comprised of two sets of rectangular coils of several turns, whose planes are at an angle with respect to each other, usually 90 degrees. A pointer or needle rotates with each set of coils over a graduated scale. The two rectangular coils of each set are connected in series with each other and with an adjusting tuning condenser C and C1. Any suitable detector or wave responsive device and a pair of telephone receivers is employed in a circuit in shunt to the condenser C, C1. The Audion detector might best be chosen with several stages of amplification. This arrangement may be used for direction finding, and to a certain extent for interference prevention, where the two pairs of coils are disposed at a distance from each other. The terminals of the condensers C and C1 are connected respectively to the two sets of terminals of a double-pole double-throw switch. Connected to the blades of the switch is the detector and its associated apparatus. With the switch thrown to the left, the circuit including the two left-hand rectangular coils and the condenser C is tuned to the energy transmitted from the station D by a variation of the condenser C. The left hand pair of coils is then shifted to such a position that there is no response in the tele-

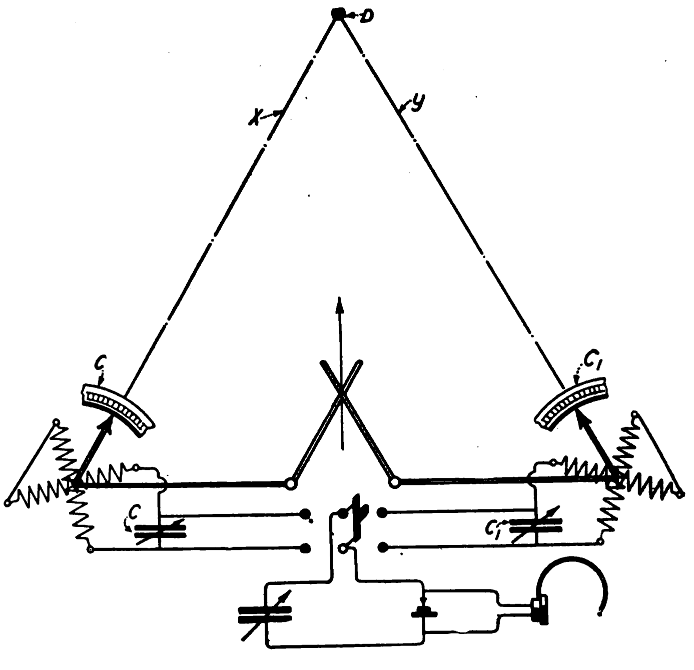


Figure 1—Circuit of Kolster's direction finder

phone in which case the needle will point at the station D. Then throwing the switch over to the right and connecting it to the right hand pair of rectangular coils the circuit, which includes the condenser C1 and the two right hand coils, is similarly tuned and the direction of station D found as before by means of the indicator on the scale.

We then have a triangle whose sides are x, y, and z, the last being the line between the pivotal axes of the two pairs of coils. The length of side z is known and the two angles between z an x and between z and y have been determined by the positions of the pointers and therefore the direction of the station D is not only accurately known but its distance may be readily computed. It will be noted that there is neither an antenna or earth connection to these devices and it is also obvious of course that the ideal arrangement for operation would consist in devising some means of remote control in order that the operator seated at the detector might revolve the rectangular coils at will.

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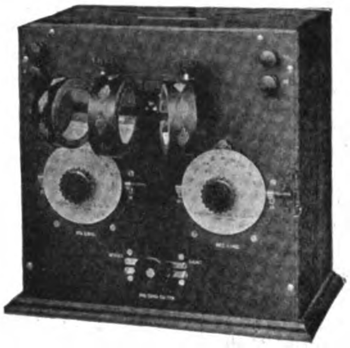

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EXPERIMENTERS' WORLD

Views of readers on subjects and specific problems they would like to have discussed in this department will be appreciated by the Editor

Experiments With Fluorescent Substances

By Thos. W. Benson

THE property of fluorescence possessed by certain chemical and mineral compounds always excites wonder and interest even in the mind of the layman or one not given to the study of the sciences. For here we have Dame Nature in one of her more beautiful moods, taking the invisible rays of light and by some mysterious process converting them into every conceivable color. With a few pieces of apparatus anyone can conduct a series of experiments and be more than pleased with the results.

The term Fluorescence was given to the phenomena on account of it being first noticed in a certain variety of fluor spar. The difference between fluorescence and phosphorescence should be clearly understood. The former is that glow emanating from a substance while under the influence of the invisible and highly refrangible rays, the latter, the property certain substances have of storing light energy and later giving it off in the dark, such as calcium and zinc sulphides. Some compounds possess both properties in varying degrees.

Though the phenomena may be viewed with sunlight as the exciting medium it will enhance the beauty of the work if use is made of ultraviolet rays. Immediately there comes to mind an arc lamp or a spark gap as the source of such rays. In consideration of those not having access to power for an arc, let us select the spark gap as the more common and obtainable ultraviolet ray generator.

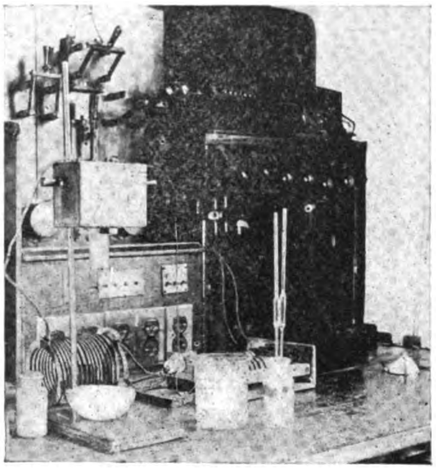
The mechanical details of such devices deserve little consideration.

A box, containing a regular or homemade radio spark gap, with a hole cut in one side is possibly the simplest form. Let those who care to tackle the problem in a more complete manner consider the ultraviolet ray generator pictured in fig. 1. Here we have a device suitable for the study of the various effects of ultra-violet light in addition to its uses as an exciter for fluorescence.

A small wooden box is fitted with binding posts to support two iron electrodes. The electrodes are rounded at the sparking end and extend through the sides of the box to be fitted with insulating handles for the purpose of adjustment. Terminals are arranged on the top of the box to allow of ready connection to the other apparatus.

A one inch hole is cut in the bottom of the box which has fastened below it a tin tube to confine the rays in a downward direction. The tube is soldered to a sheet of tin bent in such a form as to allow the insertion of glass or other substances in the path of the rays.

The generator is supported on a ring stand by means of a universal burrette clamp with the outer clips removed and a screw passed through the rear of the box into the body of the clamp. This construction gives a handy form of generator suitable for many experimental uses.



Apparatus used in performing the experiments with fluorescent substances

A spark coil, ranging from ½" up will operate the gap nicely, the limit of power with the construction described is about ¼ kw., beyond this the heat and noise is objectionable. The regular radio condenser is used, or in fact any condenser giving a good heavy spark will be suitable. Likewise the helix or tuning inductance of the radio set is utilized. A few turns of heavy stranded wire on a cardboard tube will suffice if a helix is not handy.

Wire the outfit as shown in the diagram, close the primary circuit and adjust the gap to the greatest length giving a steady spark. When adjusted the platform will be flooded with ultra violet light mixed with the visible blue and violet rays.

A few beakers and saucers are all that is required in the line of apparatus. The chemicals needed will be mentioned in their proper place.

Take a breaker, fill it nearly full with clear water and stand it on the platform. Float a strip of horse chestnut bark on the surface and start the gap, extinguishing all the lights in the room.

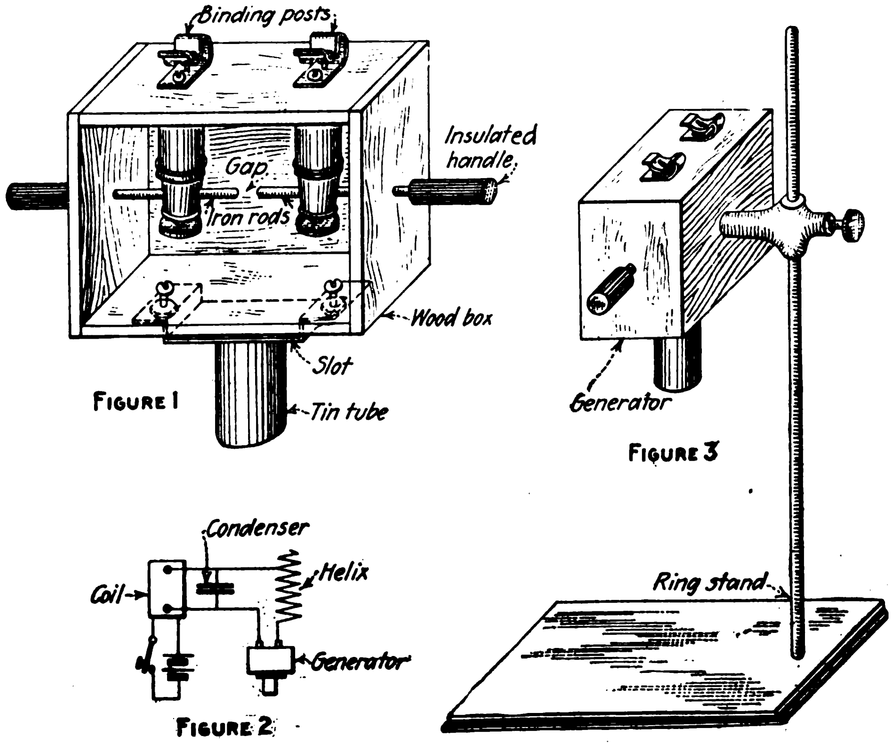
In a few minutes a stream of bluish gray fluid, asculin, will be visible clinging to the bark like barnacles to a boat. In ordinary light this is not noticeable but the rays of ultra violet light are so altered by this substance that they become visible.

If some of the bark is boiled in water and filtered the solution appears colorless but a tube of it held in the ultra violet light shows a blue glow.

Soak a strip of paper in this solution and allow sunlight to pass through a prism and fall on the strip. It will be found that the length of the spectrum obtained in this manner will be much longer than that obtained without the treated paper, the treated paper making visible the more refrangible ultra violet light beyond the visible violet.

A very beautiful experiment may be performed with the red ink in common use. It will be noticed that when a large blot of this ink dries it has a greenish tinge in spots. We can demonstrate this phenomena in a rather startling way in the following manner.

Take a deep glass vessel with parallel sides, a tall beaker or cylindrical graduate will do, and fill it with water. Stand this on the generator platform and allow the water to become perfectly quiet and settled. Gently deliver a drop of aniline ink to the surface of the water with a pipette while the generator is operating. The drop will begin to contract but at the centre will descend in the form of a tube, the denser coloring matter forming the outer rim. But instantly the tube spreads into a parachute of waving red and green the edge of which breaks up into tubes to go through the same phases of the parent stem. The figure retains its shape for several minutes and is very beautiful with its slowly moving waves of green. By transmitted light it appears pink but viewed at an angle by reflected light it appears a brilliant green. Viewed from above the figure is very peculiar; the edges glowing with a fine golden tinge. By placing a drop of heavier colorless liquid (sulphuric acid will do), on the surface the figure is put into motion and looks like a sea weed disturbed by water current.



Detailed construction of the ultra-violet ray generator

Put a small quantity of crude resin oil on a watch glass and place on the generator base. This oil is nearly opaque but when the spark gap is operating it shows a delicate sky blue fluorescence. The same phenomena is noted when paraffin oil is used. This is quite colorless by transmitted light but glows with a bluish tinge at the edges.

Obtain some nettle leaves and place them in alcohol, bruise them in the solution with a glass rod and allow to soak for an hour. Filter the mixture and pour into a watch glass or beaker. The liquid will appear a bright green. Now take a piece of cardboard with a hole ½" diameter and hold over the solution and start the generator. The path of the rays will be of a blood red hue. Tinctures of other vegetable substances have a similar effect on light. That of stramonium gives a pale green fluorescence, guaiacum, a beautiful violet color, turmeric a greenish tint.

The coal tar colors are very remarkable in their effect on light. If a beaker of water is placed on the generator stand and a few grains of fluorescence gently placed on the surface they will begin to sink slowly to the bottom leaving behind them yellow trains with a brilliant green fluorescence. The experiment succeeds with most artificial dyes that water dissolves slowly, markedly so with eosine and crythrosine. The non-fluorescent dyes such as malachite green, coceine and French red leave behind a train of one color. A very beautiful effect is obtained by mixing together several grains of each substance and placing them simultaneously on the surface of water in the beaker. A truly startling bouquet of colors result, interweaving and mingling to give a wonderful color effect. By arranging a strong light behind the glass vessel and allowing the transmitted light to fall on a wall or white cloth a remarkable color spectacle results.

A weak solution of sulphate of qui-

(Continued on page 29)

Wireless in the A. E. F.

The strike of the printers in New York forced the withdrawal of the instalment of this remarkable series planned for this issue. The series will be continued in the next number and will appear regularly hereafter under the authorship of

Lieut. Col. L. R. Krumm and Capt. Willis H. Taylor, Jr.

A Well Made Grounding Switch

By C. H. Biron

READERS who have used slate base switches as a safety measure for grounding the aerial have invariably traced a fair amount of lost energy to leakage through the slate which often bears such mineral qualities as to make its use prohibitive for high frequency work.

For those who have yet to install such a switch the accompanying design may hold some suggestion. Here a single pole slate base switch is used but under conditions that make its mineral content immaterial. Prototypes of this switch as used in up-to-date power work make use of corrugated porcelain supports known as bus-insulators. However, the petticoat type of standard porcelain pin insulator is more suitable for outdoor service and can be obtained at central stations for a reasonable price.

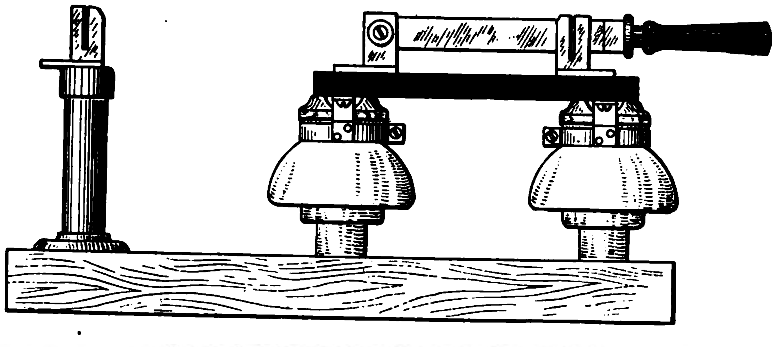


Figure 1—Side view of the grounding switch

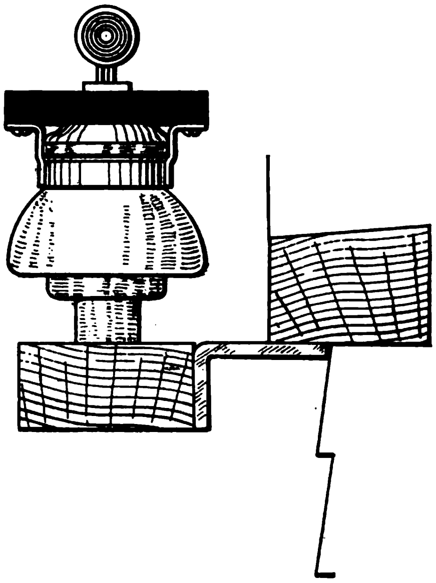


Figure 2—End view, showing method of mounting

A size that is commonly used for city service primary lines is four inches high overall and four and a half inches at the widest diameter. The tie wire groove in this size will permit the use of five-eighths by one-eighth strap iron as a clamping strip. To this strip is riveted the bracket pieces that in turn are bolted to the switch base. This construction is clearly shown in the side and end views, figures 1 and 2.

Wood pins form the supports for the insulators. They may be of somewhat smaller diameter than the sockets of the bushings and compounded in with melted rosin or sulphur. They are then forced into holes in the wood base which for symmetrical appearance should have a cross-section of approximately two by four inches. Wedges from the bottom will secure them from any future loosening.

The ground standard need not be insulated and may take any form that suits the builder, but the one shown is in keeping with the design and consists of a suitable length of standard one-inch pipe fitted with a standard floor flange and pipe cap.

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This cap should be drilled and the switch jaws mounted before assembling to the pipe.

The end view in figure 2 shows a convenient bracket arrangement for mounting the switch to the window ledge where it is easily reached from the station window.

The lightning switch is one of the exterior fixtures about a radio station, which should have a neat appearance.

EXPERIMENTS WITH FLUORESCENT SUBSTANCES

(Continued from page 27)

nine to which has been added a small quantity of dilute sulphuric acid when placed under the generator has a delicate blue tinge.

The so called "Canary Glass" which is yellow by transmitted light gives off a beautiful green glow when placed on the ultra violet ray generator platform. This is due to uranium salts present which are highly fluorescent.

There are also a number of minerals that have some subtle power over light. Willmite the natural silicate of zinc gives a brilliant green glow when placed on the generator base, and silicate of soda gives a blue glow.

There naturally arises need for an explanation of this phenomena. We can only explain the fluorescence by inductive reasoning. Inasmuch as the rays causing fluorescence are located beyond the violet end of the spectrum the substance absorbs these rays setting the molecules into vibration, these in turn set the ether around them into motion resulting in the emission of visible light. This theory is supported by the fact that should the indicent rays be polarized the resulting fluorescence is not polarized showing the light is re-generated, so to speak, in the sensitive substance.

An Inexpensive Lead-in Bushing

By C. H. Biron

EXCEPTING those procelain tubes used for house wiring, there are few stock articles that improvise well in place of electrose bushings for admitting the aerial lead to the operating room. Even porcelain tubes fall short of the desired ends due to the fact that unglazed porcelain is unsatisfactory for outdoor service.

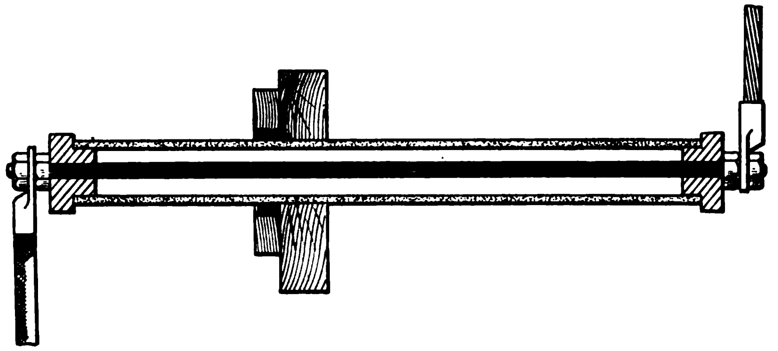


Figure 1—Horizontal section view of the lead-in bushing

A good substitute is found in glass water-gauge tubes which are available at a reasonable price in any steam-fitting shop. These tubes are made with heavy walls to resist mechanical strain and when selected for clearness (freedom from coloring) their insulation value is sufficient for all practical purposes.

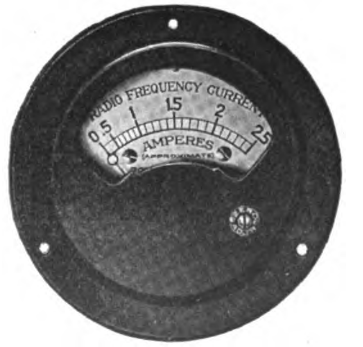
There use resolves itself into a question of mounting them and closing the ends to moisture and dirt. In the illustration shown, both ends of the tube are closed by turned maple bushings through which a quarter inch round brass rod passes, fitted with nuts that hold the assembly together and provide fastening for the cable terminals of aerial and instrument leads.

The tube itself is mounted in a sash board similar to those used for ventilating. The reader whose set is located where it is undesirable to drill through the wall or window pane will find this means of overcoming the difficulty entirely satisfactory. This arrangement provides quick and easy access to the lightning switch where it is located on the window ledge outside.

If the tube is a snug fit in the board a little shellac will secure it from loosening or creeping. The writer used an extra piece of board with a somewhat larger hole and filled the space with storage battery "dope."

This piece is shown in section in the drawing. The maple ends should be given a coat of black shellac and a finishing coat of spar varnish before assembling.

The sash board may be painted to match the sash or in harmony with the trimmings of the house.



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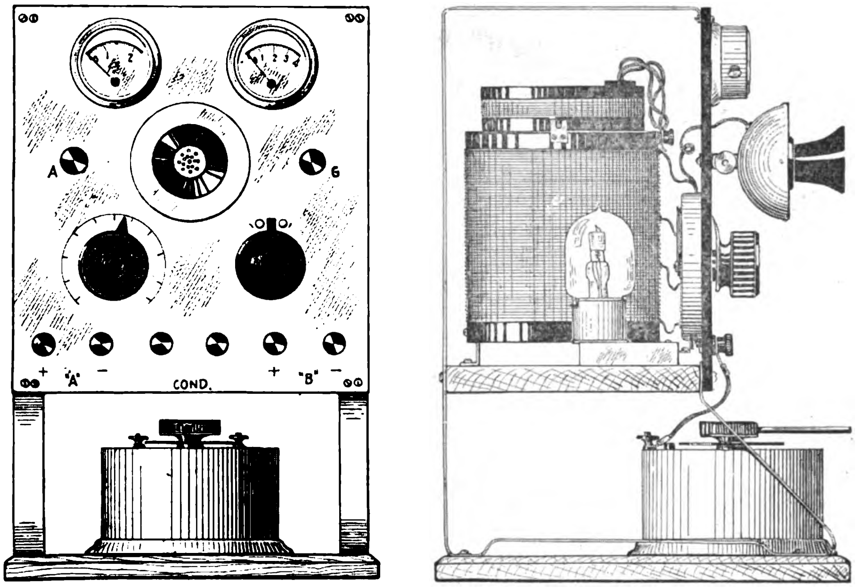
A Laboratory Radiophone

By J. Pignone

As FAR as the average amateur is concerned radio telephony is in its infancy as yet. The chief causes of this are, the amateur has not had an opportunity to experiment, and the pre-war vacuum tube was not of proper design to withstand a high voltage. However, the modern high vacuum tube presents very favorable prospects for the development of the amateur phone.

New circuits and schemes are constantly coming forth. This places the layman in a confused state, for no sooner would he have a specific set completed than a new circuit would come to his attention.

It is for this reason that I have designed the panel shown. There is nothing fundamentally new and it is comprised of the following: a direct current ammeter and also a high frequency meter, a transmitter, condenser (variable oil), grid condenser and leak, inductance, bulb, and controls.



Figures 1 and 2—Front and side views of the laboratory radiophone

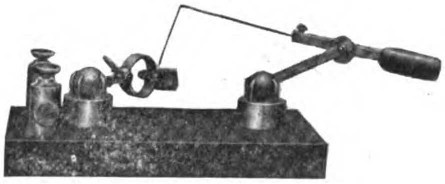
The wiring to the different elements is not soldered directly to the respective binding post, but to a copper terminal, which in turn is connected to the element. This accounts for the adaptability of all circuits. The inductance in this set is interchangeable. The primary is wound on a bakelite tube 6 inches by 6 inches with 20-23 Litz. It is tapped three times. As can be seen in the diagrams (figures 1 and 2) the support bearings for the secondary are slotted. The result is that any sized secondary can replace the one described. It is 4½ inches in diameter by 2 inches, wound with 20-38 on a bakelite tube. Leads from the coil are brought out by flexible wires to binding posts mounted on the primary tube itself. There are three binding posts, the center one being for a tap brought out from the middle of the secondary.

The tube to employ for this set depends upon circumstances—the source of current available, and the pocket book. However, a Marconi V. T. class 2 would readily adapt itself to this work.

If the transmitter employed "sticks," the following can be resorted to. Obtain an empty receiver shell and mount two or three "Skinderviken Buttons" insulated from the diaphragm with mica washers and the buttons connected in series. This will prove a fairly sensitive transmitter capable of withstanding heavy currents.

As accessibility and flexibility were the keynote to the design of this set, it was not found feasible to mount the panel in a cabinet. This and the fact that an oil condenser can only be used in a vertical position, made it necessary to mount the panel on heavy copper strip 1 inch wide. The size of the panel is 11 x 12 inches, the base attached immediately to it is 7 x 11 and the size of the base proper is 12 x 12⅛ inches.

This will prove a very valuable accessory to the "dabbler's" laboratory and there need be no fear for any circuit as the connections can readily be changed.



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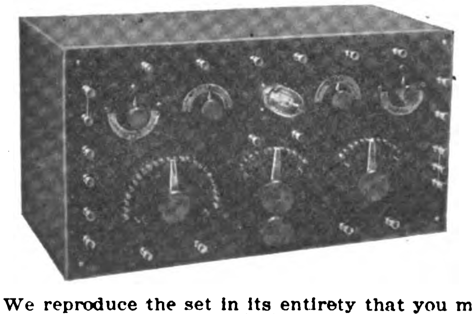

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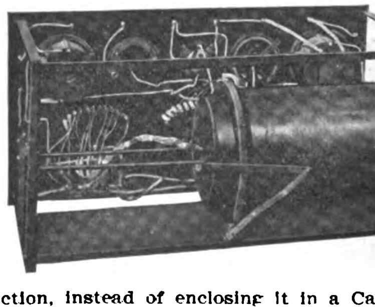

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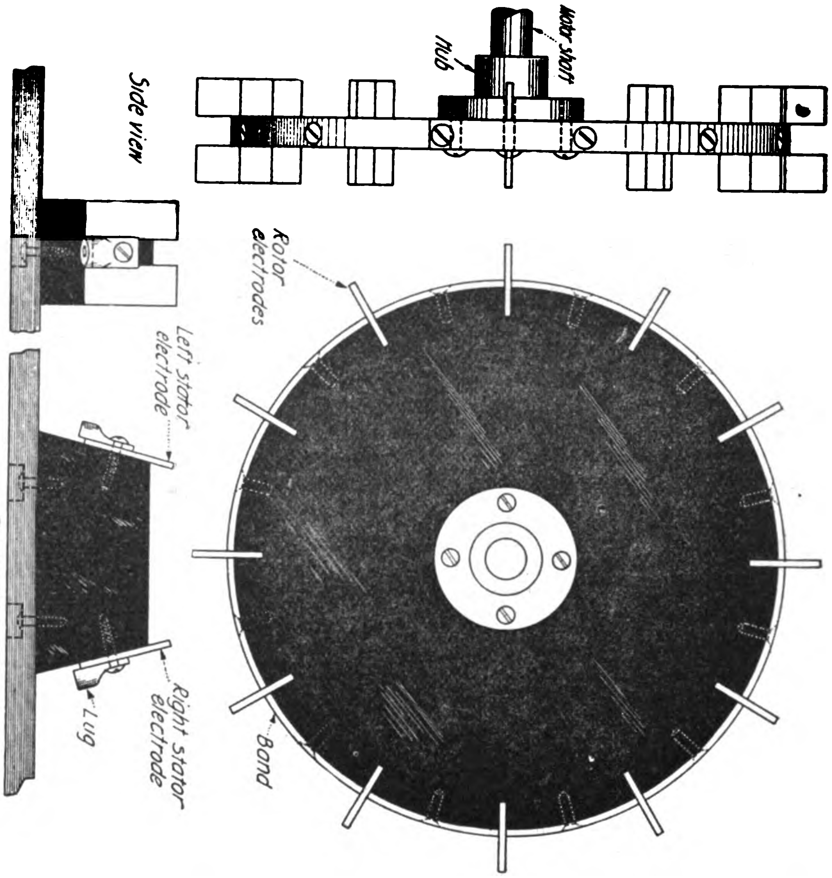
First Prize—Mechanically and Electrically Efficient Rotary Spark Gap

By L. D. Dillenback



The assembled rotary non-synchronous spark gap

THE accompanying drawings show the assembly and details of a very efficient rotary non-synchronous spark gap suitable for stations up to one kilowatt input. The chief advantage of this design arises from the fact that the energy passes into the gap on one tooth of the rotary and out again on a tooth next to the first mentioned. This short path is highly essential in connection with work at 200 meters.

No motor is shown, as the available motor for each particular amateur will vary. This motor should be capable of standing approximately a load of one-sixth horse power at 200 revolutions per minute. A suitable wooden block may have to be constructed to raise the center of the motor shaft 6 1/8 inches above the base.

The main disc is machined from a piece of sheet dilecto 8 inches square. After turning down in a lathe to 6 7/8 inches in diameter, twelve slots 1/16 inch wide and 3-8 inch deep are cut radially from the circumference, each 30 degrees apart. Between the slots are 10-32 tapped holes 5/8 inch deep. Holes are also drilled for the shaft hub as indicated in the drawing. In this connection it will be well to first fasten the finished brass hub to the unfinished disc in accordance with the drawing. The hub can then be placed on a mandrel and the disc turned true in a lathe.

The hub is of brass and should be machined in accordance with the drawing. No dimension of the shaft diameter is given because this will vary with the individual motor. This hub should be made from a piece of brass stock 2 1/8 inches in diameter, a hole being drilled in the center the same size as the shaft diameter. A piece of steel of the diameter of the shaft is then pressed into the hole and the piece finished in a lathe. The disc can then be screwed to the hub and finished in the lathe.

The stator electrodes are filed from sheet copper 1/16 inch thick. Two are required.

The rotor electrodes are also filed from copper sheet in the manner indicated for the stator electrodes. It is recommended that a steel filing

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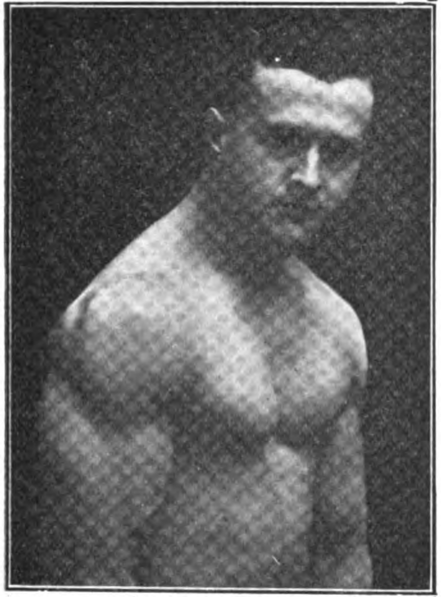

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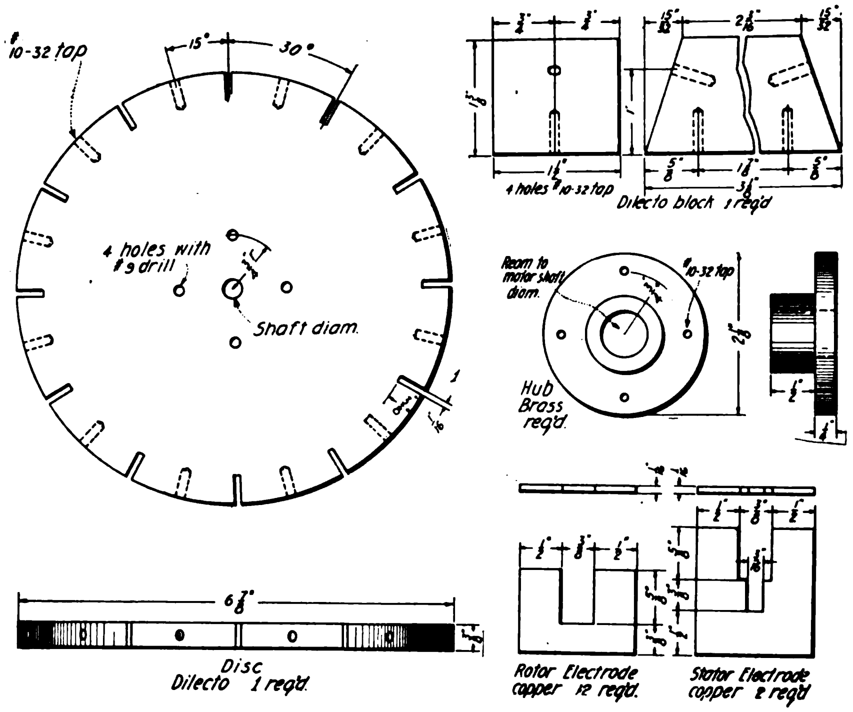
jig be made in accordance with the drawing and twelve pieces of copper sheet be clamped to the jig. The copper pieces can then be sawed, drilled and filed to a finish. This is only necessary when no milling machine is available.

A dilecto block drawing is given, showing the method of supporting the stationary electrodes. A copper lug is placed under the electrode clamping screw for connection. It will be noted that the electrodes may be adjusted easily for proper relation to the rotor electrodes, which are non-adjustable.

In the assembly of the disc it will be obvious from the drawings that the rotor electrodes are held in the disc by a brass band 1/8 inch thick by 3/8 inch wide. This piece of brass should be annealed before bending in place. This is accomplished by heating the brass to a dull red and plunging it into cold water. The brass should then be stretched around the circumference and cut off to the proper length. Holes should be spotted and drilled, and counter-sunk for 10-32 flat head brass machine screws. After stretching the brass band around the disc and spotting the holes right through the brass into the dilecto disc, the band can be taken off and tapped holes made in the dilecto disc. The rotor electrodes can then be inserted and the band placed back in exactly the same place, this time screwing in the flat head machine screws. The disc should be mounted on the motor and tested for true running of the electrodes being corrected by filing where necessary.



Detailed construction plans of spark gap

Second Prize —The Ideal Amateur Rotary Gap

By Arno A. Kluge

In designing the ideal rotary gap for an amateur radio station there are certain conditions which ought to be satisfied, and the closer we can approach these conditions, the more nearly ideal will be our gap. Briefly these conditions are:

1. A quick break in the circuit, giving good quenching.
2. Ample sparking surfaces, so resistance is low.
3. Accurate adjustment of electrodes.
4. Moderate rate of speed.
5. Reasonable simplicity of construction.

The necessity for opening the primary circuit quickly after a spark has passed across the gap is the primary consideration. Authorities agree that four oscillations in the primary circuit are sufficient to transfer all the energy to the secondary or aerial circuit. The resistance of the gap should then become so high that no energy can be re-transferred from the secondary, which would produce complex oscillations and consequently a broad wave. (See "Practical Wireless Telegraphy," Appendix G, for a further discussion.) If we are to have only four oscillations in the primary circuit, for a 200-meter wave the gap should open in 4/1,500,000 seconds, or 0.00000266 seconds. Practically, of

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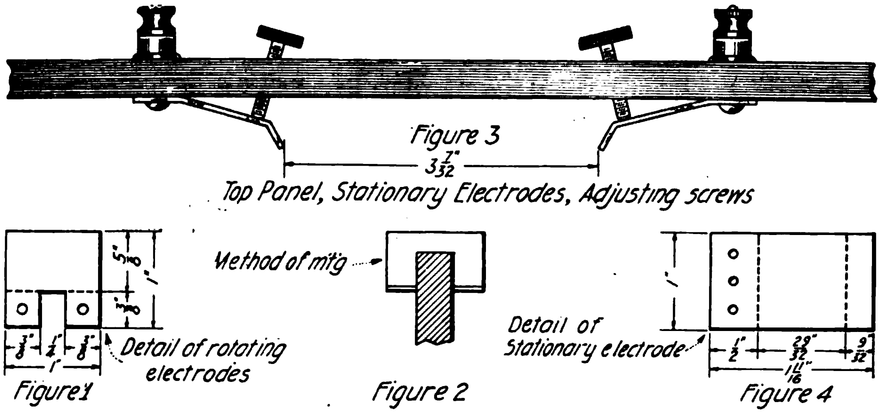
course, this is impossible of attainment, but by the use of knife edge electrodes, mounted on a fair-sized disc, we can come much closer than with the half-inch plugs used on the old style amateur rotaries.

The rotating member of this gap is a disc of ¼-inch Bakelite, 12 inches in diameter. Twelve slots are cut into the periphery of this disc, at equal distances apart, and along a line running through the center of the disc. These slots are cut with a 1/64-inch hack saw blade, to a depth of ½ inch. Figure 1 shows a detail of the electrodes, which are made from 1/64-inch aluminum sheeting cut to the dimensions shown. The two lugs provided are bent along the dotted line at right angles, and the electrodes are then slipped into the slots as in figure 2, leaving ⅛-inch projecting from the disc. When all are in place, two brass strips 3/8-inch wide and 1/16-inch thick, and having holes drilled at the correct distances, are used to bolt all the lugs of the electrodes together with small machine screws. The nuts should be soldered on these screws to prevent any possibility of loosening. This construction will be clear from figure 5 which shows the rotary disc complete. The hub shown can be any suitable mounting which will fit the motor shaft and to which the disc can be screwed.

The stationary electrodes consist of two copper strips, 1 inch wide and 1/64-inch thick. Figure 3 shows the method of mounting these strips on the top panel of the enclosing box, including binding posts and adjusting screws. If desired, these adjusting screws may be provided with insulated handles, and also lock nuts—a refinement which gives more accurate adjustment. Figure 4 shows the electrodes in detail, which are bent as indicated by the dotted lines.



Details of construction and mounting of the rotary spark gap

The rotary disc is mounted on the shaft of a small series motor, or a 3600-r.p.m.-induction motor. In any case the motor should be about 1/12 h.p., as the very small motors—commonly used—heat up badly on a long run, and tend to vary in speed when excessively loaded.

The rotating disc should be mounted in an air-tight chamber, with the Bakelite panel, already mentioned, for the top. Alcohol vapor may then be introduced into the chamber to aid the quenching of the gap, using

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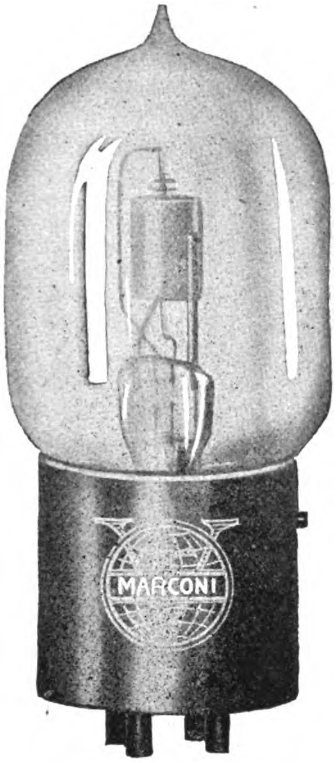

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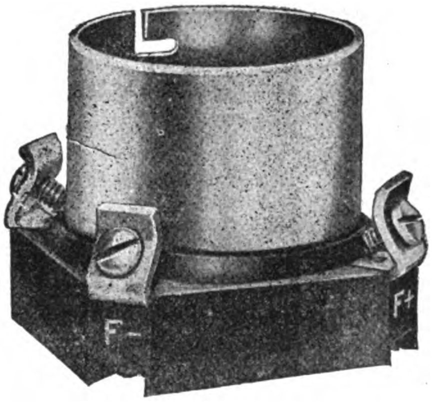

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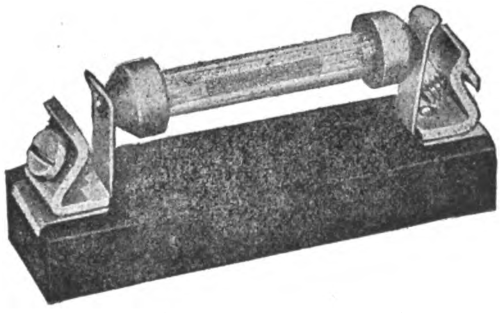

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a small oil cup with a cotton plug through which the vapor passes when the gap becomes heated. A safety valve, which may be a bicycle valve reversed, should also be provided to take care of any excess pressure in the chamber, as for example, when starting the spark. The corners of all the electrodes should be slightly rounded to prevent the spark dragging out. A red glass window placed near the top of the chamber will permit observing the spark while it is in operation.

Most spark gaps tend to maintain an arc of the power current after the oscillatory discharge has passed. This will hinder effective quenching, since the low frequency arc keeps the circuit closed. To overcome this the alternator, transformer, and condenser should be adjusted to resonance with the transformer frequency by the use of an external impedance. Then when the condenser is short-circuited by the passage of the spark, the condition of resonance is destroyed and the transformer current is materially reduced, thus preventing arcing. (See discussion of resonance by J. J. Holahan in August Wireless Age.)

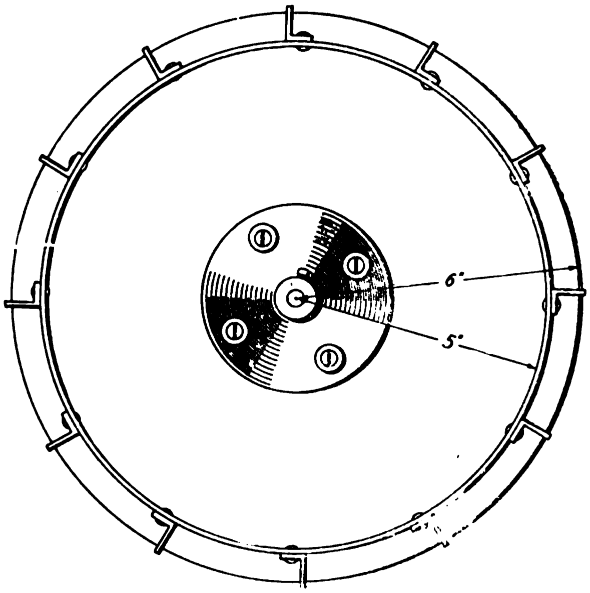


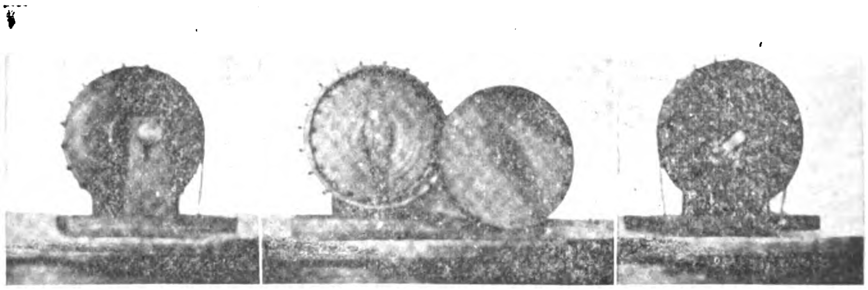
Figure 5—Rotary disc complete

By following the constructional details and technical data given in this article the amateur should be able to produce a highly efficient, almost ideal, rotary spark discharger.

Third Prize—A Good Rotary Spark Gap for the Experimenter

By R. C. Hitchcock

A NON-SYNCHRONOUS rotary spark gap with its musical pitch giving fine reading characteristics should have a place on the instrument table of every radio experimenter. With high frequency work, Tesla coils, and other applications the rotary spark discharger is widely used, for the electrodes, in revolving cool off the sparking surfaces and give greater efficiency than a straight gap.



Enclosed type of rotary gap showing front view with driving pulley and end view with cover removed and in place

The ideal gap should gain full speed in ten seconds and come to a stop in a similar length of time. When alternate receiving and transmitting is to be done, a quick starting and stopping gap is very desirable and the best arrangement incorporates a light rotating member.

The rotating arm carries two electrodes and the stationary electrodes can be of any convenient number, varying with the motor speed and the pitch desired. If an alternating current motor running at 1,800 R.P.M. is used, and 20 electrodes are placed in the stationary disc, a good musical note will be produced about 600 sparks per second. If a higher gap speed is desired with a constant speed induction motor, pulleys may be used to advantage. The speed of a direct current motor may be regulated by a field rheostat, or one directly in series with the current supply.

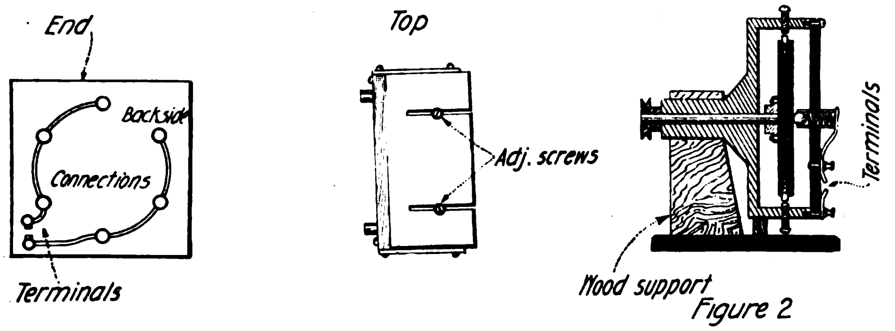


Figure 2

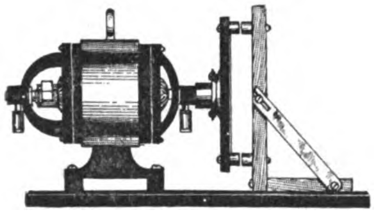


Figure 1

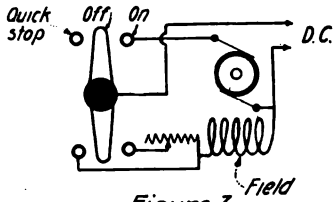


Figure 3

The open type spark gap in detail and circuit used

The open type gap shown in figure 1 is very easy and inexpensive to construct. The requirements are a battery motor, some electrodes—zinc or brass screws are preferable—and sufficient wood for the frame and base. The stationary plate has its electrodes divided into two equal parts, each set being connected with a wire—the revolving arm always connecting one electrode of each set, completes the circuit. The rotating arm is simply a piece of wood, beveled to cause less air resistance, one electrode on each end connected with a copper strip. The arm is fastened to the motor by bolting to a pulley, or a bushing. The distance between the electrodes is easily varied by moving the stationary plate by means of the adjustable wood screws—this is made clear in the diagram. A gap of this type with a stationary disc 6 inches in diameter and 12 electrodes, connected to a motor operated on a storage battery, has been successfully run at 6,000 R.P.M.

When a direct current motor is used to run a gap it may be stopped as quickly as desired by disconnecting the armature, and permitting the field current to flow. In practice, a series-rheostat is set at the point where the motor can be quickly stopped without appreciable jar. A convenient wiring diagram for this is shown in figure 3. To save battery current the lever should be turned to the "off" position when the motor has stopped.

Where the noise of an open gap is objectionable the enclosed type is of interest. The casing is of cast iron, with brass screws for electrodes which are easily adjusted for any spark length. The rotating member is of wood, on the ends of which are two brass screws which are filed flat after being inserted. The contact is made in the center of the rotating arm by means of a spring ball bearing, the casing being the other connection. The contact construction is plainly shown in the diagram. To guard against the high tension current which is grounded to the gap casing, jumping into the motor windings and causing damage, a belt connection to the motor must be used.

This rotary gap consists of two gaps in parallel, and they may be fixed for distances as small as 1/64 inch. A safety gap of about ⅛ inch placed across the terminals is a wise precaution.

The fixed electrodes will give a snappy break to the spark, if placed ¾ inch or more apart and will also give a clearer tone to the transmitted note. The addition of a rotary spark gap to a station will greatly improve the sending range, and the better musical pitch being more audible through static, will be appreciated at the receiving station. A gap of this type with 20 electrodes has been operated with success at speeds of 4,000 R.P.M.

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Note: It is not at all uncommon in these days of supersensitive receivers for a small spark coil to transmit 25 or 30 miles or even more. A good many amateurs must for various reasons be satisfied with a low power transmitter. The great majority of these use a spark coil with the spark gap in the antenna to their own detriment and to the great inconvenience of all who may be listening for distant stations.

There is a better way. The use of tuned circuits will result in a marked increase in range of any transmitter and the elimination of all unnecessary interference.

For the good of all concerned those of us who have "dope" on an efficient low power transmitter will welcome the opportunity here offered: and those of us who are required to use the smaller outfits will be thankful for information which will surely make for an increased range.

New England Wireless Amateurs Meet

A MEETING of the New England Amateur Wireless Association was held at the Franklin Union, Berkeley Street, Boston, recently with an attendance of about fifty. Mr. G. R. Entwistle presided and a very interesting talk was given by Mr. Henry C. Gawler, First District Radio Inspector, who spoke of the practical use of the amateur stations.

A trans-Atlantic relay is now under development to transmit from the Atlantic Coast to the Azores, or to England direct, in an attempt to improve over the record made just before the war when a message was relayed from New York to San Francisco in one hour and twenty minutes, only passing through five stations each way.

Attention was called to the fact that the radio regulations and laws are the same as in 1917, when amateurs were first silenced, except that the code test is now twelve words a minute.

Advance orders for reservations to the Second Annual Banquet of the Association, to be held in the near future, can be sent to the secretary, Mr. Wallace E. Heckman, 119 Windermere Road, Auburndale, Mass.

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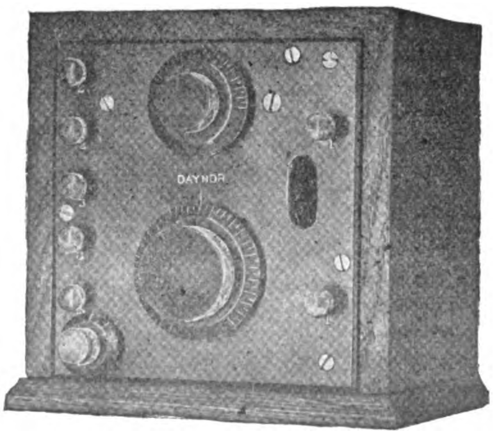

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The Quenched Gap for Amateur Use

By H. J. Tyzzer

As a result of the study and improvement of vacuum tubes for both transmitting and receiving, tube amplifiers have been constructed which have increased the range of the receiving station many times. But the tube transmitters, although very effective for local work, are limited in output, and cannot be used to any great advantage for long distance transmission. It is for this reason that the Navy deemed it advisable to adhere to the conventional 500-cycle quenched gap transmitters, equipment which has proven both effective and reliable and which has been standardized by large quantities of sets of this type, manufactured during the war.

It would then seem advisable for the amateur who wishes to transmit long distances and still adhere to government restrictions, to follow as closely as possible the path laid out by the Navy and experienced commercial companies. A method whereby this desirable objective may be attained, will therefore be pointed out.

It is assumed that the amateur has at his disposal a source of 60-cycle alternating current. With such a supply it is customary to employ a step-up transformer, a high potential condenser, some form of gap, and an oscillation transformer, together with such accessories as a key, protective devices, and radiation ammeter. The power of this equipment, however, is limited because of the 200-meter wave restriction. With such a low wave-length it is practically impossible to employ a condenser of more than .01 or .012 mfd. capacity and have allowance for inductance of leads and proper coupling. This means that a much higher voltage must be employed by the amateur than if a supply of higher frequency were available. Such a high voltage often leads to gap difficulties, condenser troubles

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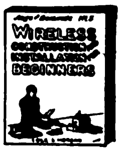

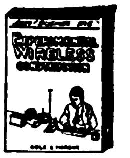

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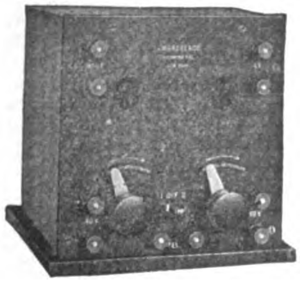

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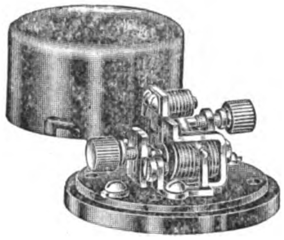

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and low efficiency. It was formerly customary to employ a plain gap which ordinarily gave a note that was anything but pleasing on 60 cycles, and which was noisy in operation. This gap also caused a wave having a very high decrement to be emitted from the transmitting antenna, which tuned broadly at the receiving station and caused a great deal of interference.

The introduction of the non-synchronous rotary gap into the amteur field marked a great improvement in transmitters in general, inasmuch as a clear note with slightly decreased decrement in the antenna circuit was obtained. Even with a rotary gap, however, the conditions are far from ideal as the efficiency is usually quite low and the decrement often exceeds the 0.2 allowed by government regulations. Or in other words, when the coupling is made sufficiently loose to bring the decrement below 0.2 the equipment is not operating with maximum radiation.

Using a quenched gap on a 60-cycle supply, investigations have been made in laboratories at Medford Hillside, Mass., and the following data recorded to show the advantages of the quenched gap.

Tests were first made with a ¼ k.w. Blitzen transformer. This type transformer is resonated to a capacity of .01 mfd. on 60 cycles. It was found impossible to work this transformer at its rated capacity with the leakage tongue, which is inserted between the primary and secondary in place. Therefore the tongue was removed and resonance sacrificed for increased output. Three mica condensers of .004 mfd. each were used, totalling a .012 mfd. capacity. The plain gap consisted of two centimeter brass balls, whereas the rotary was of the Murdock type, the quenched gap being a special one manufactured for amateur use.

A Murdock oscillation transformer was used with a phantom antenna consisting of a .00035 mfd. capacity,

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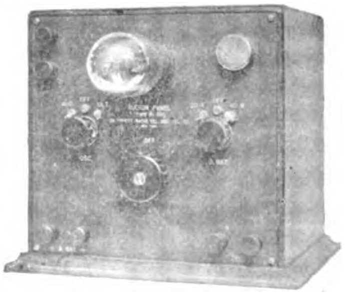

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a loading spiral and 10 ohms inserted resistance. The quenched gap was compared with both the rotary and plain gap referred to above and the following data obtained:

TEST NO. 1
Total antenna resistance—15 ohms

Gap	Input Watts	Wave-length	Watts in antenna	Efficiency
Plain	135	200	41	30.4%
Rotary ...	135	200	43.6	32.4%
Quenched..	135	200	60	44.5%

TEST NO. 2

Gap	Input Watts	Wave-length	Watts in antenna	Efficiency
Plain	250	200	73	29.2%
Rotary ...	250	200	82.5	33 %
Quenched..	250	200	94	37.5%

A ½ k.w Blitzen transformer was then tried and 10 more ohms inserted in the antenna circuit, thus totalling approximately 25 ohms, and the readings below obtained:

TEST NO. 3

Gap	Input Watts	Wave-length	Watts in antenna	Efficiency
Plain	500	200	170	34%
Rotary ...	500	200	190	38%
Quenched..	500	200	225	45%

From these readings it may be seen that a considerable increase in output was obtained—by the use of the quenched gap—and hence better overall efficiency. It was found possible, by selecting the proper number of individual gaps for a given power in the quenched gap unit, and by adjusting a variable reactance in the primary of the transformer, to obtain an exceedingly clear note of double frequency (120 cycles). This means a double discharge per alternation of the 60-cycle wave and gives a pleasing tone resembling that of a rotary gap running at low speed.

The transmitter was then connected to an L type antenna consisting of two wires 60 feet long and approximately 55 feet high. With 200 watts input the maximum antenna current obtainable with the rotary gap was 1.6 amperes. With this setting the decrement as determined with a Kolster decremeter was approximately 0.6. The coupling on

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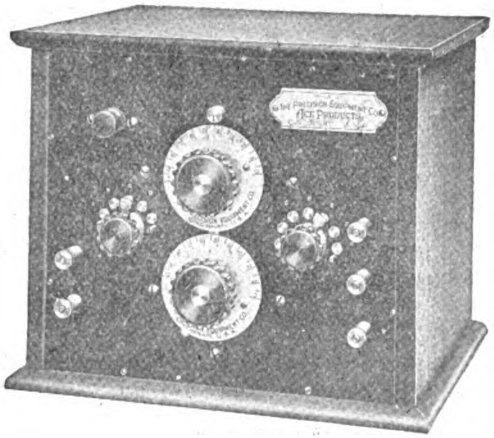

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the Murdock oscillation transformer was reduced until the primary and secondary coils were nearly at right angles. In this position the antenna current had dropped to 1.1 amperes and the decrement decreased to 0.2 the maximum value permitted by government restriction. It was found, however, that this 1.1 amperes at 0.2 decrement was far more effective than 1.66 amperes at 0.6 decrement. This was determined by observing the deflection of the wattmeter in the decremeter circuit in both cases leaving the coupling conditions between the antenna and the decremeter the same. We have all heard that the reading of an ammeter in the antenna circuit is an untrue indication of effectiveness with a plain or rotary gap, and this is absolute proof of that fact.

The rotary was then replaced by the quenched gap and with the same power input—200 watts—a radiation of 2.1 amperes was obtained. The decrement was only 0.12, which is well within the limit set by the government.

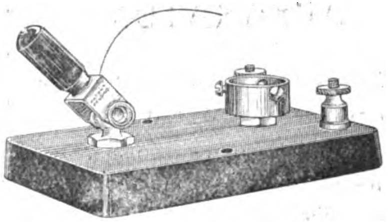
Note the comparison under these practical working conditions. With a 200 watt input, 1.1 amperes radiation with the rotary and 2.1 amperes with the quenched gap; and, as the energy in the antenna is proportional to the square of the current this means a ratio of 1.21 to 4.41 or, in other words, that the quenched gap is over three and one-half times as effective as the rotary.

With the rotary gap considerable difficulty was experienced with kickbacks which punctured the insulation on the transformer and blew fuses, etc. With the quenched gap, however, none of this trouble was noticeable. In operation the quenched gap was almost noiseless, which is an obvious advantage when it is considered that a great deal of amateur long distance transmission is accomplished in the early hours of the morning, when disturbances are not relished by the household or the neighbors.

With a rotary gap very high potentials are built up in the antenna circuit, which tend to strain and even rupture the insulation. With a quenched gap this is not true, as the sparks follow each other regularly and are of uniform potential.

Briefly, then, the advantages of the quenched gap over its nearest competitor, the rotary, may be summed up as follows:

1. Increased efficiency of transmitter.
2. Practically noiseless in operation.
3. Less potential in antenna system.



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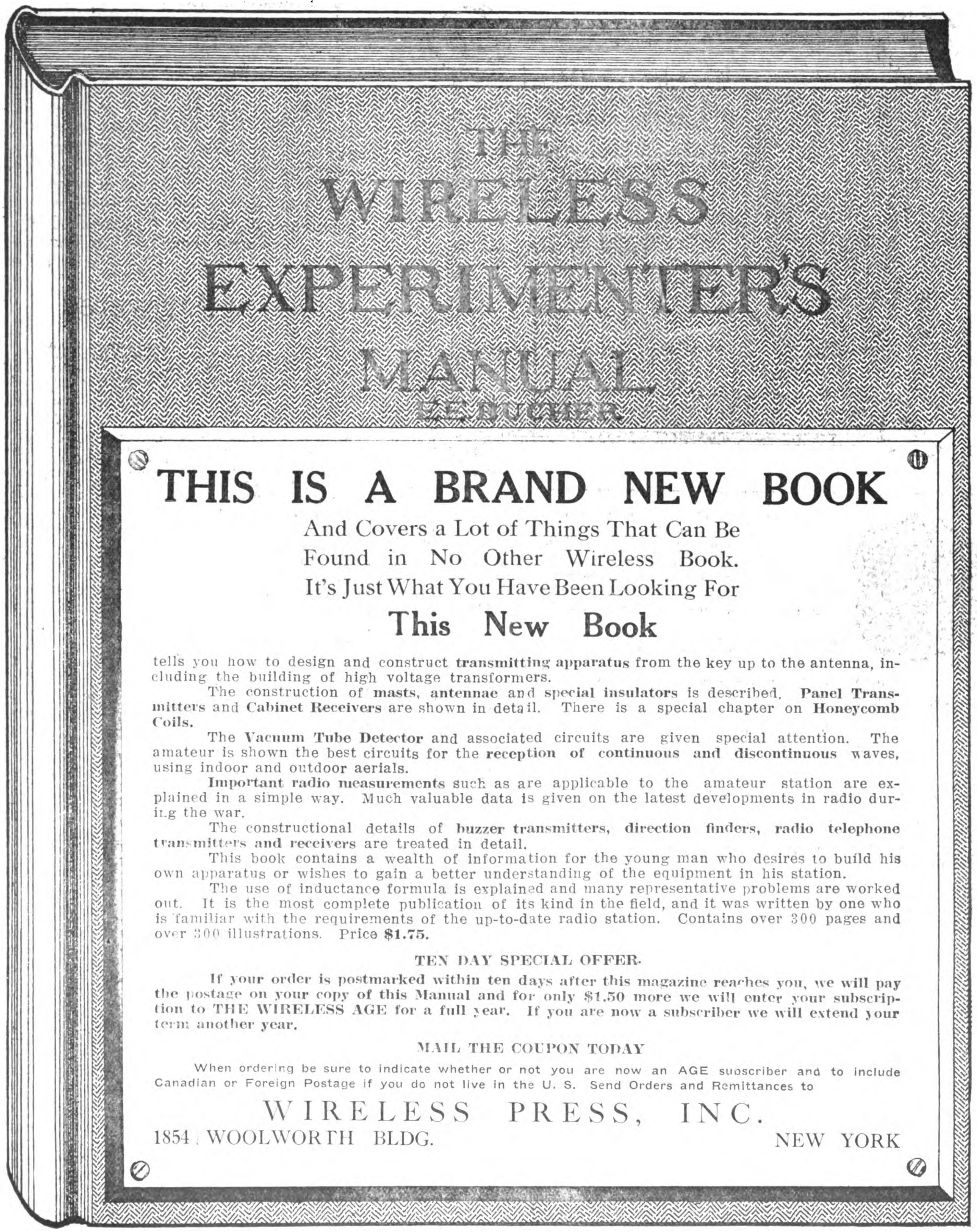

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P. M. H., Whitneyville, Conn.

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Of The Wireless Age,' published monthly at New York, N. Y., for October 1st, 1919.

County of New York.
ss.
State of New York,

Before me, a Notary Public in and for the State and county aforesaid, personally appeared E. J. Nally, who, having been duly sworn according to law, deposes and says that he is the President of the Wireless Press, Inc., Publisher of The Wireless Age, and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management (and if a daily paper, the circulation), etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, embodied in section 443, Postal Laws and Regulations.

1. That the names and addresses of the publisher, editor, managing editor, and business managers are:

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2. That the owners are: (Give names and addresses of individual owners, or, if a corporation, give its name and the names and addresses of stockholders owning or holding 1 per cent or more of the total amount of stock.)

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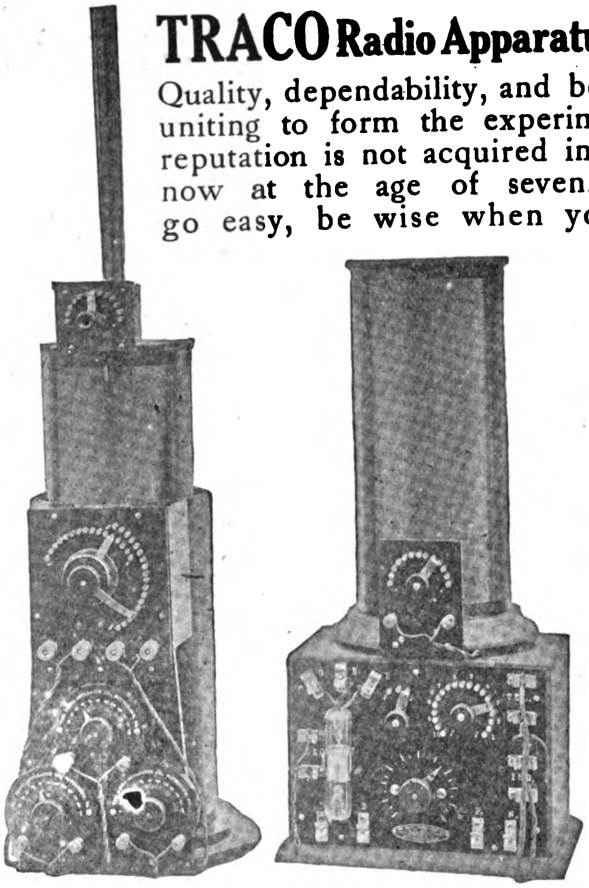

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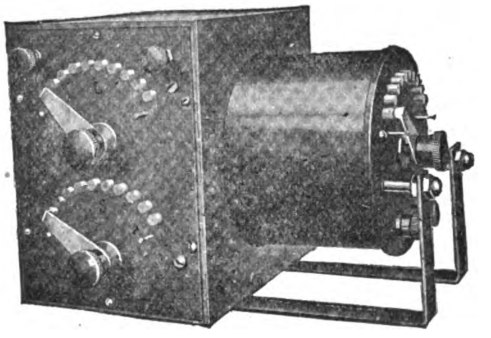

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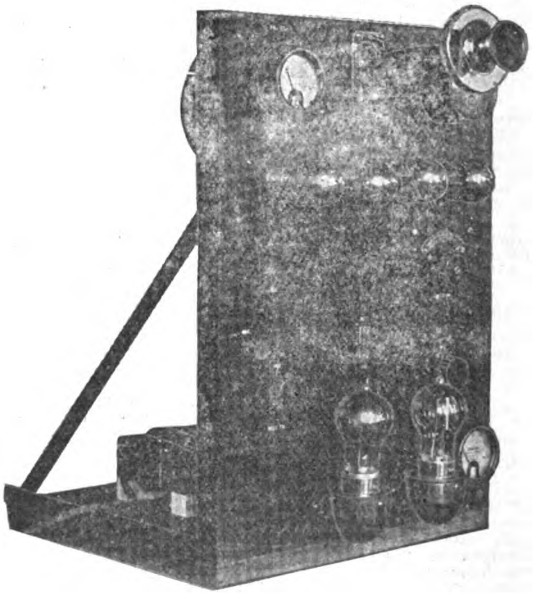

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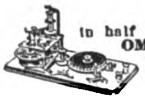

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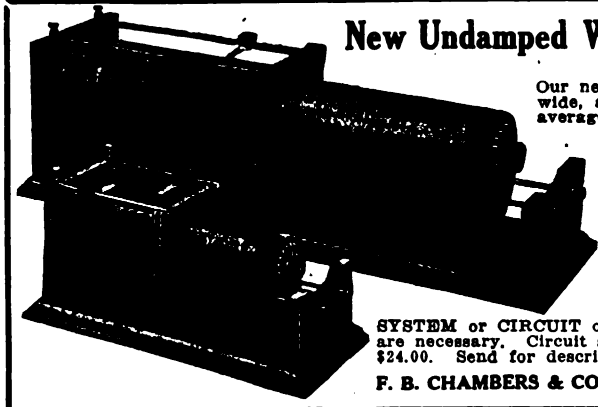

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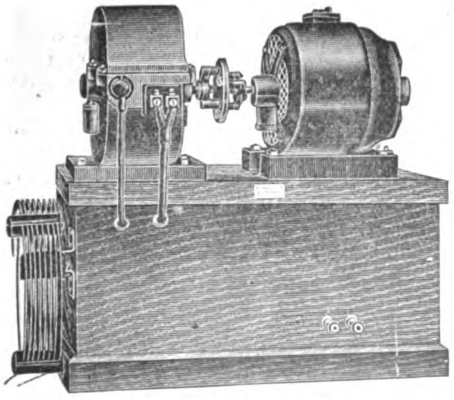

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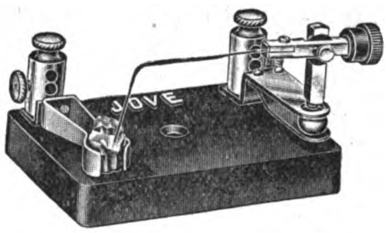

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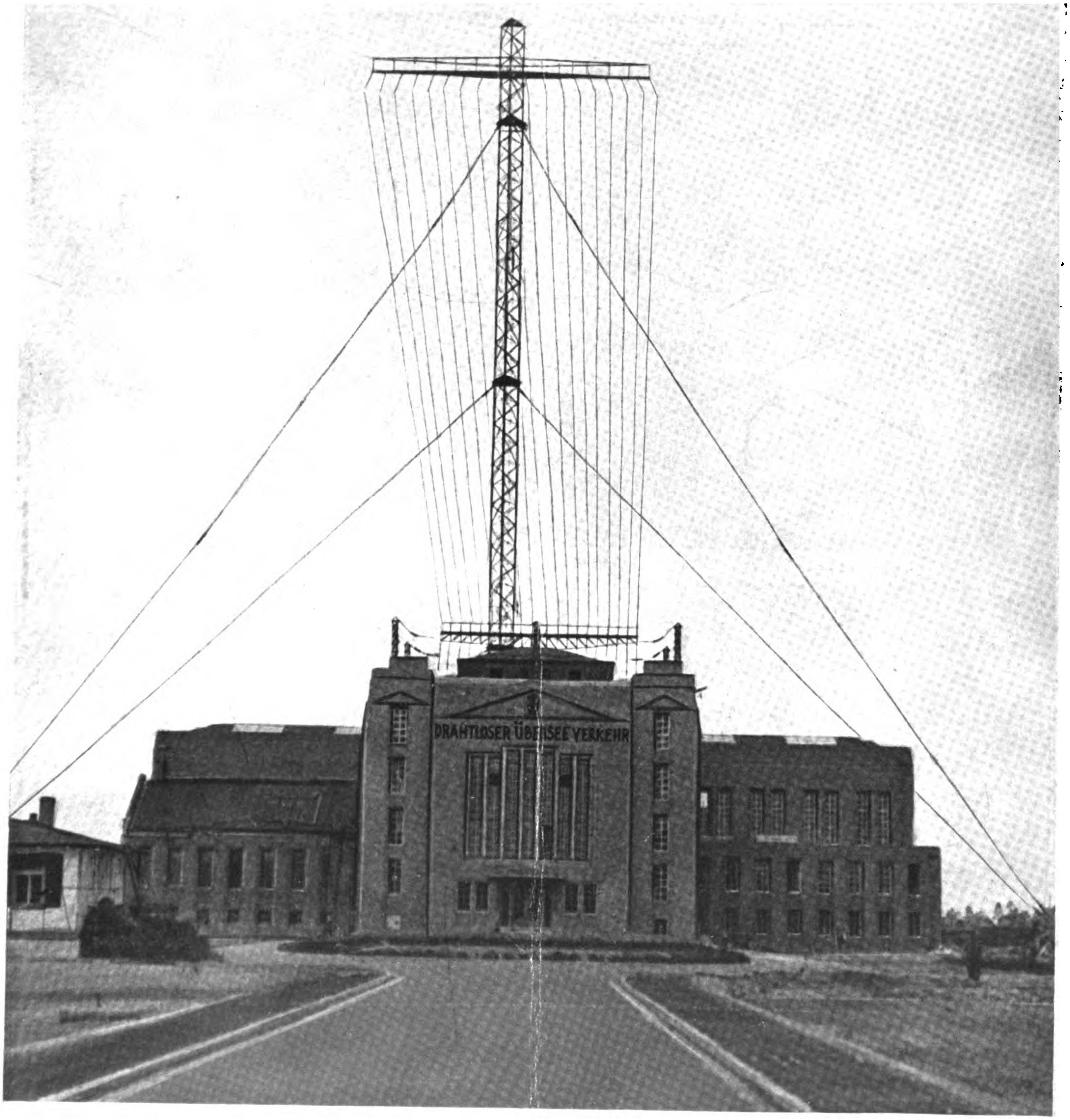
The WIRELESS AGE

Volume 7
Number 3



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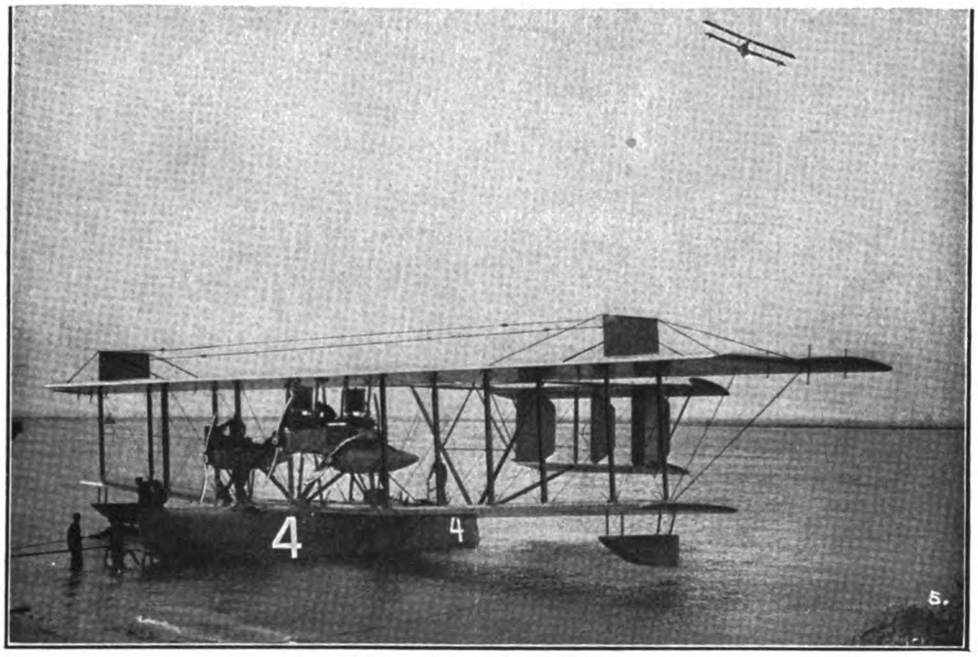
Extract from New York World, June 3, 1919.



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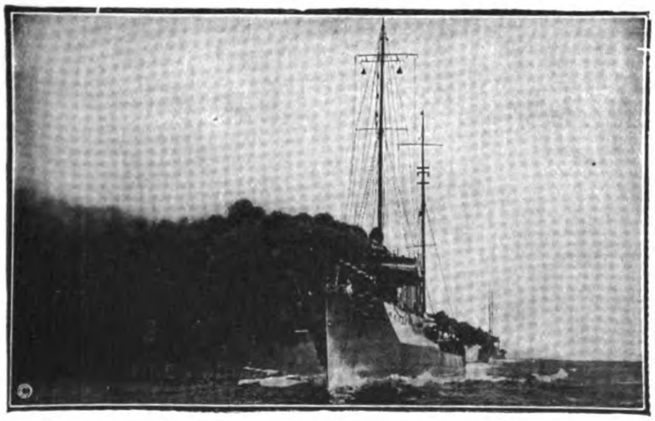
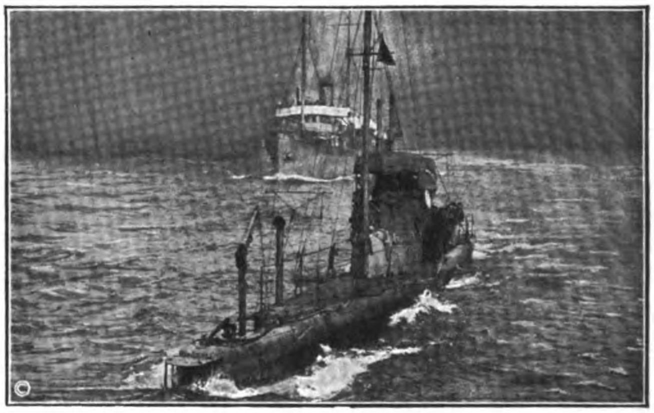


U. S. S. Cassin and U. S. S. McDougal Working Up a Smoke Screen—ELECTROSE Equipped.



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The Wireless Age

Edited by J. ANDREW WHITE

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Vol. 7 No. 3

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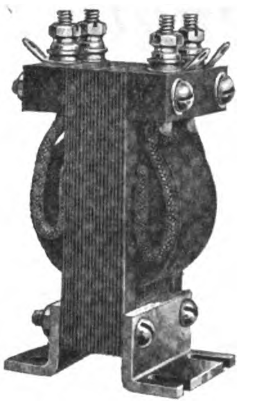

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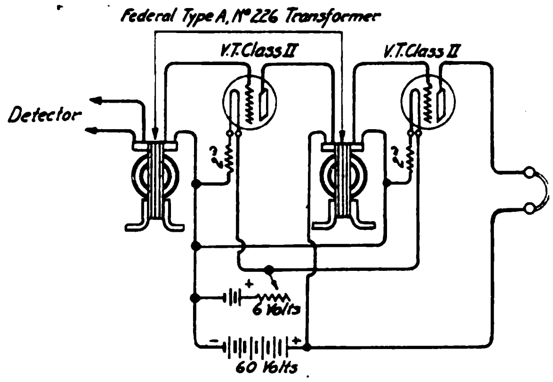

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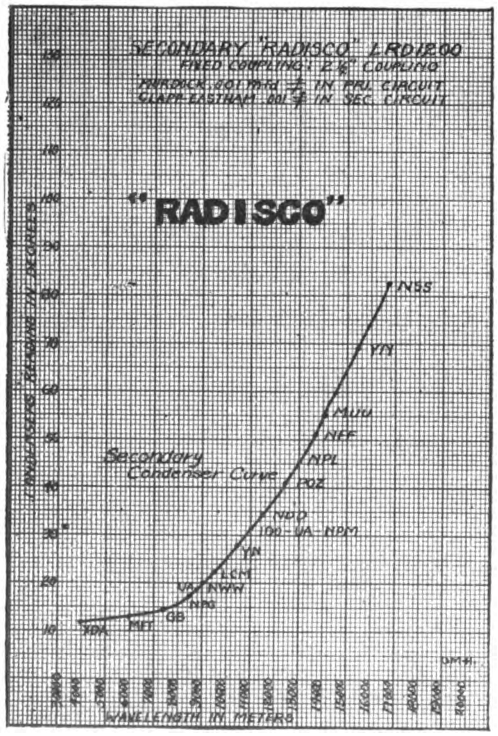

shows the performance of "RADISCO" long-wave coils used at Brookline, Mass., with a short amateur antenna. All the stations noted were received in several hours time—and but one tube was used.

European Stations for $6.60!

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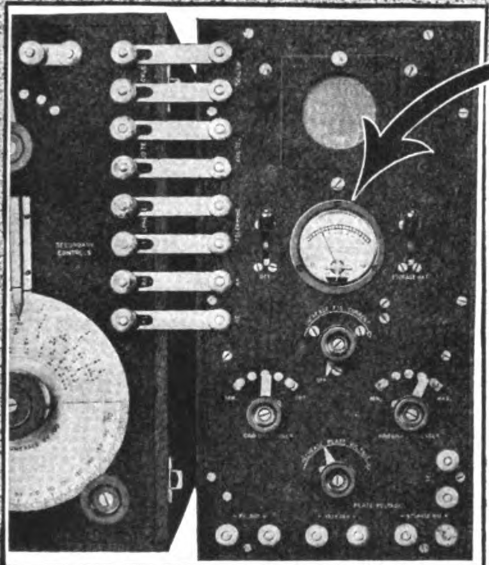

Audion Control Box Showing Type BX Instrument for Measuring Filament Current.

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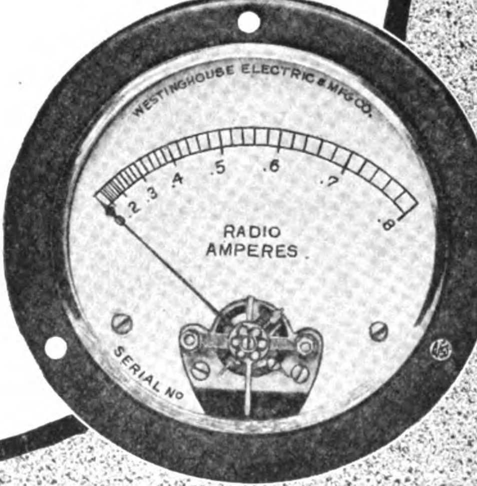
was especially developed for Radio application. Operating on the D'Arsonval principle, it will measure vacuum-tube filament currents and other direct currents used in wireless work, while for radio frequency currents it is provided with a self-contained heater and thermocouple.



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TYPE WI-105A
Single Detector Stand. (Navy Type with galena crystal.)

TYPE WI-106A
Audion Control Box. Can be used with any type of receiving circuit.

TYPE WI-107A
Aerotype Receiver and Two Stage Amplifier, combined. Wave length range: 200 to 3,000 meters.

TYPE WI-111A
Single Vacuum Tube Base Socket.

TYPE WI-112A
Double Vacuum Tube Base Socket.

TYPE WI-114A
Triple Vacuum Tube Base Socket.

TYPE WI-120A
Grid Condenser. Small mica Dielectric condenser. Capacity: 0.0006 Mfd.

TYPE WI-121A
Telephone Condenser. Small Mica dielectric condenser. Capacity: 0.0025 Mfd.

TYPE WI-122A
Grid Leak Resistance. Glass enclosed. Moisture proof.

TYPE WI-126A
Crystal Detector. Dust proof—enclosed type.

TYPE WI-129A
Audion Control Box. Provided with filter system so that in addition to the plate battery of 40 volts, 110 volt supply may be used in the plate circuit.

On this page, in the next or subsequent issues, will be announced additional designs with their type numbers, etc., as well as other developments of interest to the art.

WIRELESS IMPROVEMENT COMPANY, Inc.
Radio Engineers, Manufacturers and Distributors,
47 West Street, New York, U. S. A.

If this page is cut out and appended to the same page cut from the editions to follow, a complete file of very interesting information will soon be available. (No. 1)

VOL. 7. NO. 3. DECEMBER, 1919

THE WIRELESS AGE

WORLD WIDE WIRELESS

Wireless to Improve the Aerial Mail Service

THE Aerial Mail Service has developed a most powerful loop radio for communication of mail planes and their guidance through all sorts of weather, even fog. This equipment is now being installed on the new mail planes and landing fields at College Park, Newark, and Bellefonte, Pa.

The radio set has an unusual range for sending. Its possibilities have not been fully determined. Instead of requiring masts from 200 to 500 feet high, the aerial wires are being raised on masts only 23 feet high.

Included in the equipment is a field marking radio device, which enables a pilot to steer exactly for the center of his landing field, although it may be invisible and obscured by clouds, rain, snow, or fog.

Fog is the aviator's most dangerous enemy. A majority of crashes and bad landings are caused solely by the inability of the pilot to determine his position and the location of a suitable landing place. A new compass has been devised and put in service on the mail planes, but one of the most important contributions to aviation being worked out by the aerial mail service, with every prospect of success, is a non-magnetic and non-gyroscopic compass which will overcome the unreliability of the magnetic compass caused by vibration and other disturbing features of an airplane in motion.

* * *

Greek Ships Equipped With Wireless

GREECE has required radio equipment on all cargo ships of 1,000 or more tons dead weight capacity and on all cargo ships of 1,000 or more tons.

* * *

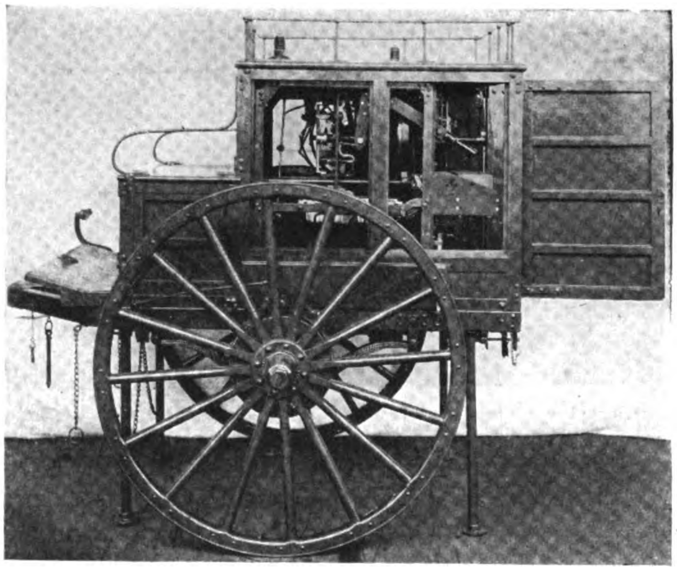
Dr. Alexanderson Reviews Recent Radio Developments

DR. E. F. W. ALEXANDERSON, consulting engineer for the General Electric Company, recently addressed the Schenectady section of the American Institute of Electrical Engineers on radio development.

"As free as the air" is no longer a true simile, Dr. Alexanderson said, because it will soon be as crowded as Fifth Avenue. Only 10,000 to 20,000 meter length wireless waves can be used for inter-oceanic communication. Under present conditions there is room in this range for about 12 stations, of which five are already in use. But, because some of these existing stations have been sending out irregular waves it has been impossible to use the maximum number of stations. By using the new alternator invented by Dr. Alexanderson, it is possible to run seven automobiles, as it were abreast in the space formerly taken by one automobile, because seven messages may be made to keep their own path so that messages can be placed within one per cent of each other, and thus seven times as many stations can be placed within the world as was formerly possible.

It is also possible to send more than one message on the same wave length due to the invention of the "barrage receiver" which cuts out all messages but those from the direction in which one wishes to receive a message. To get these signals pure, a special alternator is driven by a direct alternating current motor, whose speed is kept constant to within 1-10 of 1 per cent by means of special control equipment. The speed with which the messages can be sent has been increased from 20 words a minute to as high as 500, with 100 being a good average.

The result of all of these improvements has been to open up possibilities of communication facilities 125 times greater than those now existing.



Wireless cart of a greatly improved type designed for the Brazilian army by Marconi engineers

Marconi Fund for Italian War Relief

IN connection with the general work of the Italian War Relief Fund of America, a special fund in honor of Marconi is being raised by an electrical committee of which the members are T. C. Martin, chairman, Dr. Elihu Thomson and J. W. Lieb. Considerable success has attended this laudable effort and the Marconi Fund has already reached over $3,500, and a first instalment of $2,500 has been forwarded to Senator Marconi in Rome.

In view of the fact that sore distress in Italy deepens as the winter advances it is believed that many others in the electrical field, as well as outside it, would like to embrace this opportunity presented by the special fund and the Committee therefore renews its plea for aid and co-operation.

Each subscription is accompanied by an autograph card, with the object of assembling all these cards later in a memorial album to be delivered to Mr. Marconi. Such cards can be obtained from the Committee at 29 West 39th street, New York City.

Spanish Station Being Improved to Reach America

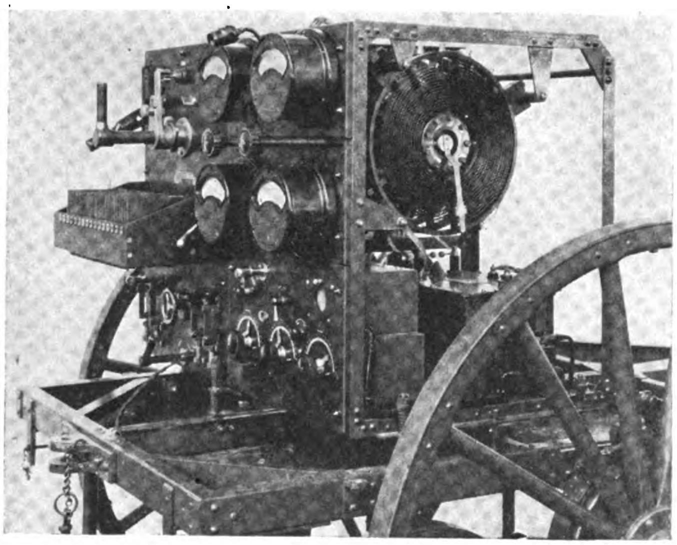
IMPROVEMENTS are being made to their important Spanish radio-telegraphic station at Carabanchel, four miles from Madrid, with a view to opening wireless communications with America if possible. This station was used, it is said, to maintain communications with Germany during the war.

* * *

Ship Maintains Wireless Communication Across Atlantic

THE distinction of having been the first trans-Atlantic steamship to maintain wireless communication with England during the entire voyage westward has been made by the Cunard Line vessel, Royal George. A long message was received from the Marconi station at Cornwall when the ship was 150 miles from Halifax.

A new valve amplifier, which doubles the distance at which messages can be received, was used on a passenger steamship for the first time. British ships were equipped with the apparatus during the war.



Interior view of the American-made signal corps radio cart equipment designed and built by Marconi for army service in Brazil

Canadian-Japanese Wireless Communication Being Effected

CONSTRUCTION of a high powered wireless station, which when completed will be the most powerful radio depot in the British Empire, is proposed for the vicinity of Vancouver, B. C., by the Canadian Marconi Wireless Company.

The station, which will cost, it is estimated, in the neighborhood of $2,000,000, is designed to handle commercial business between Canada and the Orient, and a station of like power and cost will be built in Japan. Negotiations are being carried on simultaneously with the Governments of Canada and Japan for licenses to construct and operate the two stations necessary to establish direct communication across the Pacific.

* * *

Long-Distance Wireless to Ships at Sea

MARCONI'S Wireless Telegraph Company, London, announce that long-distance messages can again be accepted for transmission through their high-power wireless station at Poldhu in Cornwall to ships which are not within range of any other British coast station. The Poldhu station communicates to ships at night only and its range is about 1,500 miles.

American-Japanese Direct Wireless Service to Open

THE new high power Japanese wireless station which will communicate directly with a radio station on the Pacific coast of the United States, will be completed soon. Trial exchange of messages will at once be made with the American station and if satisfactory results are obtained the radio station will be opened to the public for the acceptance of messages.

Construction of the Japanese station was started in 1918 and the total expenditure has been about $360,000. The sending station is located at Tomickamura, a village in the prefecture of Fukushima, about a hundred miles north of Tokio.

* * *

Norway's Stavanger High Power Station Opened for Service

THE opening of the high power radio station on the western coast of Norway, near the city of Stavanger has been accomplished and is regarded throughout Norway as marking a new epoch in the communication service between northern Europe and the United States.

The Stavanger radio, which has been ready for business since a short time after the war broke out, but has not been opened until now, is the biggest radio plant in Northern Europe, and was built by the Norwegian Government in co-operation with the Marconi Company. It is expected to handle a great deal of the business correspondence between America and the countries in Northern Europe, as the rate is one-third cheaper than the rates for cables.

Scandinavian commercial interests in the United States have during the war increased to a very large extent, and the radio service is, therefore, greeted with the greatest satisfaction in business circles where correspondence with the United States has been hampered in various ways. The Stavanger station is able to handle unlimited traffic both ways, thereby establishing a new link between the countries of northern Europe and United States.

Consul General of Norway, Christopher Ravn, New York, says: "The long expected and now at last opened action of our wireless will be greeted with joy by all, as the wireless will make Norway's connection with America closer and more reliable, and also forward both countries' business transactions."

* * *

Sweden's Karlsborg Station Soon Ready

A STOCKHOLM dispatch received here announces that the Karlsborg radio station, the largest in Sweden, will soon establish regular communication with the United States upon the completion of a test with an American station on the Atlantic coast. The Swedish wireless plant already has established service with many countries, including England and Germany.

* * *

England Regulates Aircraft Radio

THE Air Ministry in London makes the following announcement:

The form of license to be granted for the use of wireless to and from aircraft, and the conditions under which such licenses will be granted, are under consideration. In the meantime, pending the issue of the license by the Post Master General, temporary provisional authority for the installation and use of wireless apparatus in aircraft can be obtained, in approved cases, by application to the Secretary of the Post Office.

For the present the wave length suggested for wireless

Telephony is 480 meters. This is the wave length which the existing Air Ministry W/T Stations at present employ for work with aircraft.

For the benefit of designers and others interested it may be said that the Post Master General's license when available, will probably contain provisions to the following effect:

The sending apparatus installed at any aircraft station shall be constructed so as to be capable of using waves of 600 meters interrupted continuous wave, and 900 meters continuous wave; such of the following wave lengths, namely, 220, 300, 450 and 800 meters interrupted continuous wave, and 200-550 meters, 650-950 meters, 200-3000 meters continuous wave may also be used for transmission as are authorized in writing by the Post Master General.

The use of the wave of 600 meters (hereinafter referred to as the "air-craft-ship" wave) shall be confined to the use of the system known as "Interrupted Undamped Wave or Tonic Train," or I.C.W., and the use of 900 meters hereinafter referred to as the "Aircraft Normal Wave," shall be used only for continuous damped waves or wireless telephony.

Should an aircraft station be also fitted with a supplementary installation on long continuous waves, such installation shall be so constructed as to be capable of using the wave length of 2,400 meters.

The range of wave lengths for which the receiving apparatus may be constructed is not limited, but the apparatus must be capable of receiving on 600 meters and 900 meters, and on 2,400 meters when a transmitter working on this latter wave length is installed; it must also be made to embrace any other wave length on which a transmitter installed has been authorized to work.

* * *

Australians Plan World Wireless

An offer has been made to the Australian Government to provide a permanent direct wireless commercial service between Australia and the rest of the world and it is now being negotiated, according to the report submitted by Sir Thomas Hughes, chairman of the Amalgamated Wireless Australasia, Ltd.

Sir Thomas points out that as a result of successful experiments carried out by the managing director of the concern last year, when wireless messages were received in Sydney without relay from the Marconi company's transatlantic station in Wales, a service can be established, including all classes of messages—code, plain language, deferred and press—at one-third less than existing cable rates.

"There has been some delay in this matter," Sir Thomas adds, "because under the wireless telegraphy regulations it is necessary to have a license to erect and operate wireless stations. Negotiations for this license are to be followed up and it is hoped that our Government will decide the matter without undue delay, so that erection of stations can be proceeded with.

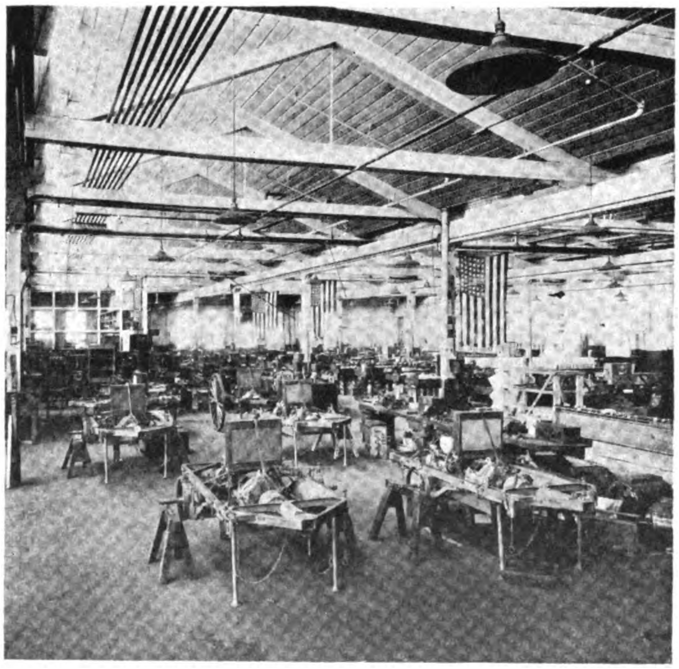
"It would be fatal to attempt to combine a naval service with a commercial service. If a naval service is needed it must be quite distinct, and it should be conducted on purely naval lines. By an attempt to combine the two we would destroy all possibility of efficiency on either side.

"The commercial service will be successful and will be capable of expansion to provide communication with almost every part of the world so long as uniform apparatus and organization are employed at all stations. There is no reason why several stations, if required for different purposes, should not be erected and worked simultaneously in Australia without mutual interference. One great company is reported to have decided to spend about $15,000,000 in improving its connections with Australia."

High Speed Radio Across the Pacific

Exchange of press despatches and commercial messages by radio between California and the Hawaiian Islands, Guam, the Philippines and Japan on a much more extensive scale will become possible when arrangements recently completed by the Government become effective about the first of the year.

Through the use of modern high power, high speed operating equipment it is estimated that it will be possible to transmit and receive more than one hundred thousand words a day between Hawaii and the Philippines; two hundred thousand words a day between San Francisco and San Diego and Hawaii, and about one thousand words a day on a slow speed circuit between Hawaii and Japan. The Hawaii-Japan circuit, operating under an arrangement with the Japanese government, will be available only nine hours a day.



View of the assembly room of the Marconi factory showing the vast quantities of army wireless equipment being manufactured for South America

Rates on press despatches over the new radio circuits will be low, insuring, in the view of officials, a widespread exchange of news between the United States and the Orient and American insular possessions in the Pacific. The rate decided on is six cents a word between California stations and Manila, and three cents a word to Hawaii.

The new arrangement, which will be open to routine commercial business, is expected by officials to aid greatly also in the building up of trade by American interests with Hawaii, Guam and the East.

* * *

Mexican Border Patrol Equipped With Wireless

The Mexican border line within the jurisdiction of the Western Department of the Army is now completely equipped with wireless telephone sending apparatus that will reach an Army airplane at any place along the border.

Colonel J. E. Hemphill, chief signal officer of the Western Department, will inspect the new equipment. Four sending stations were installed, each with a radius of 100 miles. Additional stations and possibly more powerful equipment may be installed as a result of Colonel Hemphill's visit.

NSS—The Annapolis Radio Station

The Arc Radio Transmitter—General Description

(Photos by courtesy of Navy Department)

THE Annapolis radio station is said by the Navy to be the most powerful in the United States. It was constructed by the Navy Department and is one of four high power stations which have been operated under distant control from a main station located in Washington. By means of relay, messages are transmitted through these stations by operators seated at four small tables in the Washington office of the Navy Department. Official messages were handled by Annapolis in large volume during the war, thus relieving the congestion on the trans-oceanic cables.

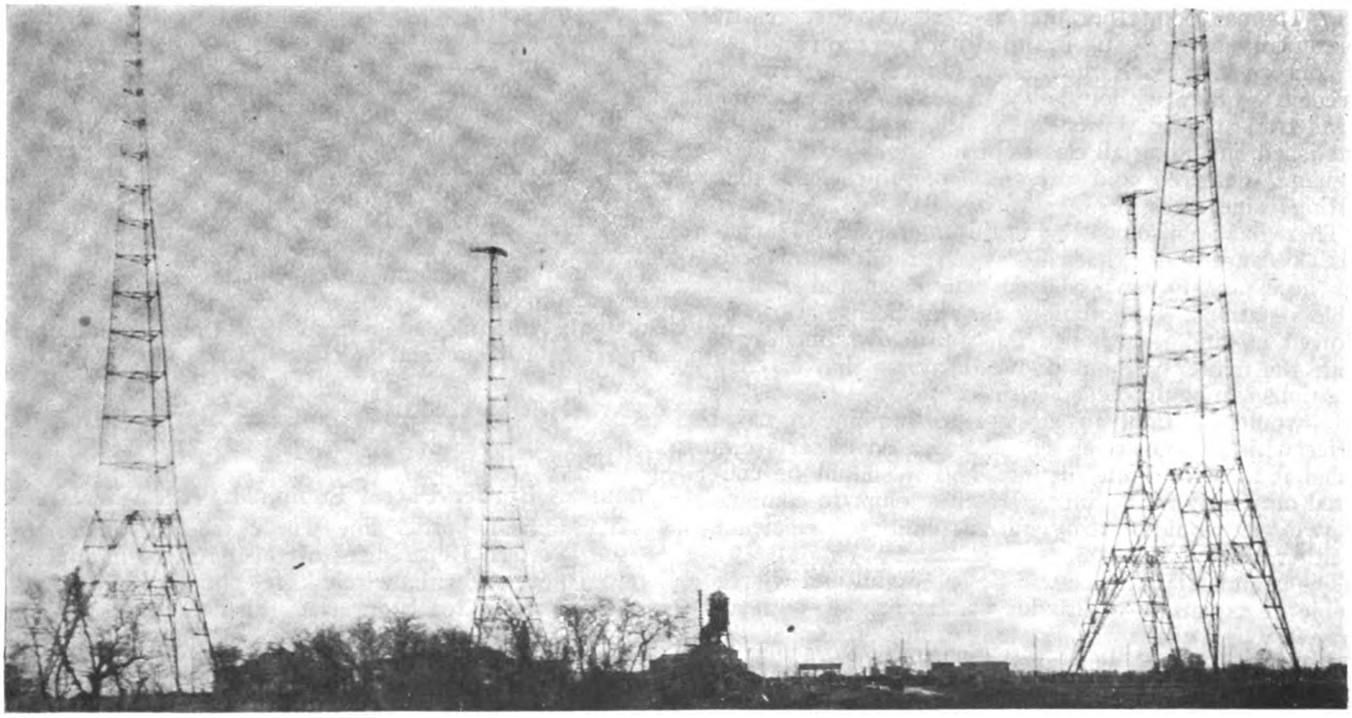
The high power arc transmitter is based upon Poulsen's method of obtaining high frequency oscillations by means of an electric arc burning in an atmosphere containing hydrogen and in a strong transverse magnetic field. The equipment consists of the following main units:

A source of direct current; an arc converter; an antenna loading inductor; an antenna and ground system; a signaling device and auxiliary and control apparatus.

The circuits employed for the set equipped with the coupled compensation method of signaling are outlined in figure 1. The electrodes of the arc converter are enclosed in a water cooled bronze chamber. To this there is supplied either a gas containing hydrogen or a liquid hydrocarbon which decomposes in the intense heat of the arc and releases hydrogen. The arc electrodes are placed between the poles of a strong electromagnet, whose winding is in series in the direct current leads to the arc, and which is therefore energized whenever the arc is in operation. When the arc is started by bringing the electrodes together and then drawing them slowly apart, a direct current arc is formed which burns in an atmosphere containing hydrogen and in a strong transverse magnetic field. This arc is shunted by a circuit containing inductance and capacitance connected in series. The capacitance may be considered as concentrated in the electrostatic capacity of the antenna to earth (the antenna and earth acting as the two plates of a large air condenser). The inductance of the circuit may be considered as concentrated in the antenna loading inductor. Under these conditions there will be superimposed upon the direct current arc a high frequency alternating current which flows in the circuit: arc, loading inductor, antenna, and earth. The arc converts the power supplied by the direct current generator into radio frequency energy with undamped current in the antenna circuit. The choking effect of the arc series field winding prevents the flow of radio frequency current from the arc back into the power machinery.

The frequency of the undamped current in the antenna circuit depends upon the inductance and capacitance of this circuit. The frequency and therefore the wavelength may be altered by changing the value of either the inductance or the capacitance. Since the capacitance is furnished by the antenna and therefore fixed, the inductance is made variable in order to permit changes in wavelength.

When the contacts of the signaling key are closed, the coupled compensation key loop becomes the short-circuited secondary winding of an air core transformer of which the antenna loading inductor is the primary. By virtue of transformer action and mutual inductance between the short-circuited winding and the main loading inductor, the inductance of the antenna circuit is varied and signaling is accomplished by the compensation method. When the signaling key is closed, the emitted wave is of shorter length than it is with the key open. The receiving set is tuned to receive the shorter wave and therefore signals are heard only when the key is closed.

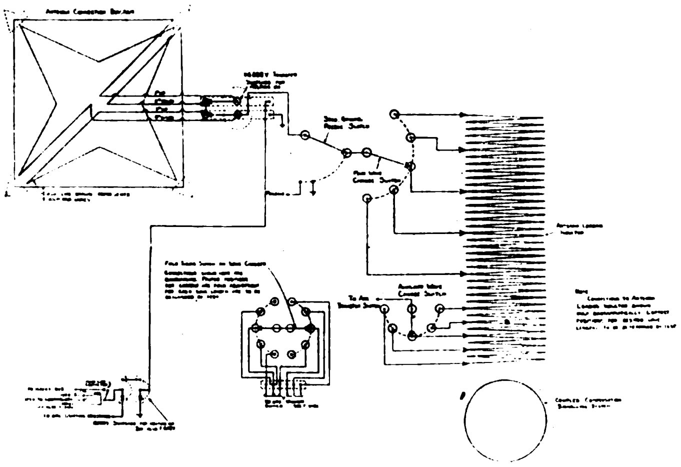


The four towers of Annapolis forming a square within which the aerial wires are strung. A feature of the gigantic antenna is the provision for melting ice from the wires by current supplied from the 400-kw. generators

A general view of the Annapolis station buildings, taken from one of the towers

The Annapolis High Power Radio Station is equipped with duplicate power machinery and duplicate arc converters, permitting practically continuous operation. Power is supplied by a 3-phase, 25-cycle alternating current source at 2,200 volts. The main pieces of equipment may be summarized as follows: Two 400-kw. motor generators, supplying direct current for the arc converters; two oil switches, through which power is supplied to the motor generators; two automatic starting panels for the motor generators; two 3-kw. motor generators supplying 125 v. direct current for operation of control circuits and arc auxiliaries; a switchboard, two arc converters, two benchboards for control of the arc converters, an arc transfer panel, antenna loading inductor, a combined wave changer and send-ground-receive switch, a signaling system and a set of switches for melting ice from the antenna.

Either of the two 400-kw. motor generators may be used to supply direct current to either of the arc converters. When one of these is in use, the other is entirely disconnected. This makes it possible to clean or repair either arc or either motor generator while the other is in operation. The arc transfer panel carries the necessary switches for transferring all the electrical connections from one arc converter to the other. A benchboard located at each arc converter carries all the necessary apparatus for the complete electrical remote control of the station equipment.



Wiring diagram of the circuits of the Annapolis station

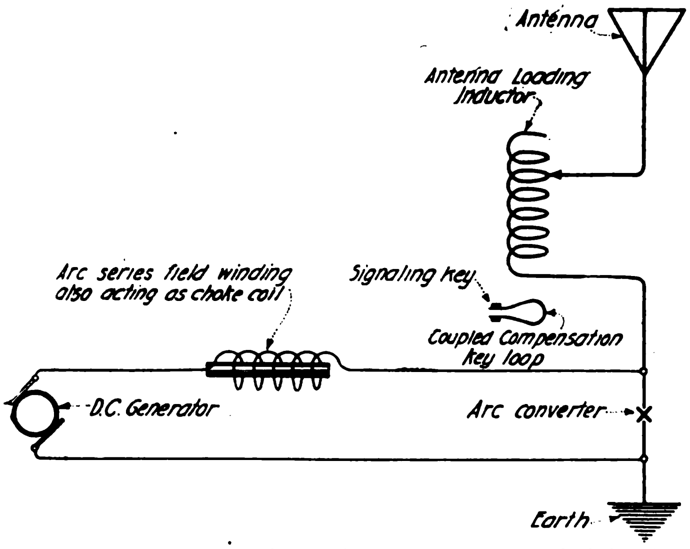

Antenna
Antenna Loading Inductor
Arc series field winding also acting as choke coil
Signaling key
Coupled Compensation key loop
D.C. Generator
Arc converter
Earth

Figure 1—Arc transmitter with coupled compensation method of signaling. The arc flame burns in an atmosphere containing hydrogen and in a transverse magnetic field set up by the arc series field winding

The motors of the 400-kw. motor generators are supplied with power from the 2,200-v., 3-phase, 25-cycle bus through oil switches and automatic starting panels. The oil switches are provided with overload protection and the automatic starting panels have no voltage protection.

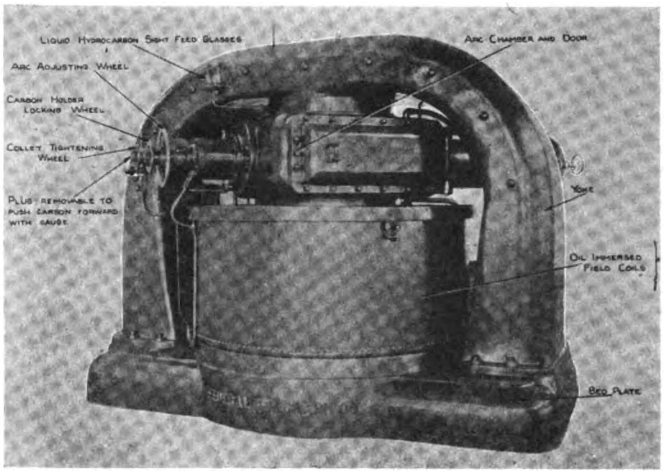
Overload protection for the 400-kw. generators is provided by relays which operate in connection with the contractors through which current is supplied to the arc converters, the contractors serving as circuit breakers between the arc converters and the motor generators.

Either of the 3-kw. motor generators may be used to supply 125-volt direct current for operation of the station control circuits and arc auxiliaries. These machines may be operated in parallel if desired.

For melting ice from the wires of the antenna, the two 400-kw. generators connected in parallel are used. A set of switches is provided for making the necessary connections.

Mounted on the same base with each of the 400-kw., 1,430-volt direct current generators are 600-hp., 2,200-volt, 3-phase, 25-cycle induction motors which drive the power units. Excitation for the generator is provided by a 3-kw., 125-volt overhung exciter. In operation, the voltage of the generator is regulated by an exciter field rheostat upon the arc control benchboard; this rheostat controls the voltage of the exciter, which in turn regulates the voltage of the main generator. Both an exciter field rheostat and a rheostat for the field of the generator itself are provided upon the main switchboard. The induction motor is of the wound rotor type.

Automatic starting panels are provided for the motor generators. These panels have no voltage protection. Overload protection is provided by relays on the oil switches through which power for the motor generators is supplied. Each starting panel is provided with three push button stations for starting and stopping its motor generator. One push button station is located upon each arc control benchboard, permitting either motor generator to be started or stopped by the arc engineer from his position at either arc. The other push button is located upon the automatic starting panel itself. A transfer switch provides for either local or remote control.


Liquid Hydrocarbon Sight Feed Glasses
Arc Adjusting Wheel
Carbon Holder Locking Wheel
Collet Tightening Wheel
Plug removable to push carbon forward with gauge
Arc Chamber and Door
Yoke
Oil Immersed Field Coils
Bed Plate

The 350-kw. arc converter of the closed magnetic circuit type

The switchboard for the station consists of ten panels: one for each motor generator oil switch; one for the two 3-kw., 125-volt direct current generators; another is a 6-circuit, 125-volt direct current distribution panel; the fifth is a contactor panel through which current is supplied to the arc converters; then there are two panels for the control of both 400-kw. generators and three panels for the control of the station signaling system.

Each of the panels for the two 400-kw. generators carries two remote manually controlled lever switches through which the generator is connected to the 1430-volt direct-current bus. Each also carries an ammeter and a voltmeter indicating the current and voltage of the generator, an overload relay for opening the proper contactor and disconnecting the generator in case of overload, a generator field rheostat, an exciter field rheostat and an exciter field switch.

The contactor panel carries four contactors for shorting out the arc series starting resistance, and two small contactors for reducing the excitation of the 400-kw. generators whenever either main line contactor is opened by its overload relay. Two high voltage main line contactors are mounted behind the switchboard upon a pipe frame. One of these acts as an arc main line contactor and serves to connect the arc to the positive 1430-volt direct-current bus. The other serves as a bus contactor and connects together the positive switches of the two 400-kw. generators. The positive bus contactor serves to protect either motor generator in case the main line switches of the other are closed when the generator is not running, or in case an attempt is made to connect the two generators in parallel without equalizing their voltage.

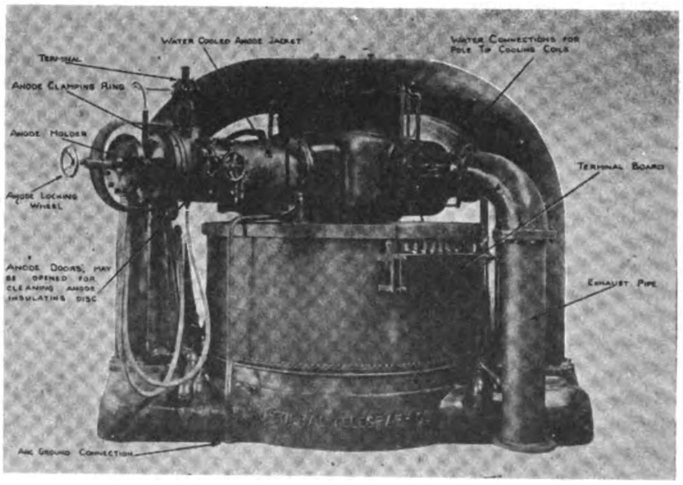
The arc main line contactor and the four arc starting resistance contactors are operated by the arc drum controller upon the benchboard. A switch on the arc transfer panel transfers the control of these contractors to the benchboard of the arc which is in use. In starting the arc, the controller first closes the arc main line contactor and then the four starting resistance contactors one at a time.

The two small contactors for the generator fields are both normally closed at all times and are opened only in case of an overload upon the generator whose fields they supply. When either of these opens, resistance is inserted in the field circuit of the generator, thereby reducing its voltage.

The two arc converters are exactly alike. Each has a normal rating of 350 kilowatts, a maximum rating of 400 amperes radio frequency current in the antenna, and a maximum direct current voltage of 1500.

The 350-kw. arc converter is of the closed magnetic circuit type. The magnetic circuit consists of a bedplate, a yoke, a lower pole, and an upper pole. The field winding is placed around the lower pole and the magnetic circuit is closed through the bedplate and yoke. The pole tips are designed to give maximum flux in the air gap between them.

The field winding consists of 15 flat pancake coils which are wound with copper strip. These are immersed in oil, giving good insulation and facilitating cooling. The six upper coils serve as a choke to prevent the flow of radio frequency current from the arc into the direct current power circuits. The remaining nine coils are used for adjustment of the strength of the magnetic field, and are provided with a series of connections by means of which any or all of them may be short-circuited. When the arc is operating on relatively short waves, a strong magnetic field is required and all of the coils are needed. On the longer waves better operation is obtained with a weaker magnetic field, and a portion of the winding must be short-circuited. A switch is provided on the wave changer for accomplishing this, and after the station is once adjusted for a given set of wave lengths no further adjustments are necessary during ordinary operation. The wave changer automatically tunes or adjusts the magnetic field to the proper strength for the wave length in use.


Water Cooled Anode Jacket
Water Connections for Pole Tip Cooling Coils
Terminal
Anode Clamping Ring
Anode Holder
Anode Locking Wheel
Terminal Board
Anode Doors, may be opened for cleaning anode insulating disc
Exhaust Pipe
Arc Ground Connection

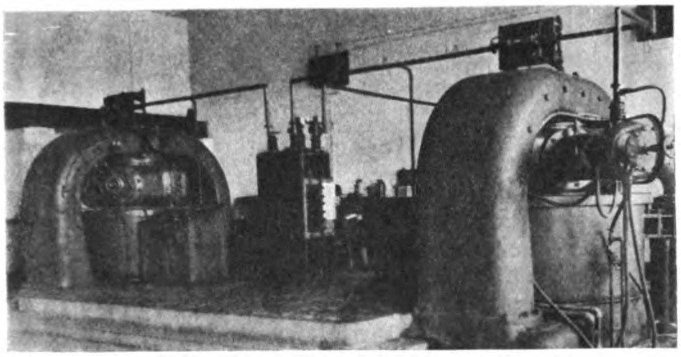
View of the reverse side of the Annapolis arc converter

The field coils are enclosed in a steel tank, which is filled with transformer oil. The cover of this tank is made of brass in order that it may not furnish a return circuit for the flux of the magnet pole.

The heat storage capacity of the coils, oil and tank is sufficient for full load operation of the arc for several hours. For continuous operation, a motor driven pump is provided to circulate the oil through water cooled coils placed in a concrete pit outside the building. The cooling water from the arc runs through this pit. It is still relatively cool when it leaves the arc and serves to remove heat from the oil.

The arc chamber is a water cooled bronze casting provided with a door on one side. This may be unbolted and opened for inspecting and cleaning the interior. The anode and cathode are bolted to opposite sides of the chamber.

The hydrogen content of the atmosphere in the chamber is provided either by city gas or by liquid hydrocarbon fed drop by drop into the arc. Two tanks, one for kerosene and one for alcohol, are connected with a sight feed drip cup mounted on the yoke of the arc above the chamber. From these cups a common feed pipe leads into the chamber through the upper pole tip. The flow is controlled by needle valves mounted on the side of the arc yolk within easy reach of the operator. The hydrocarbon supply is turned on by two small valves operated by the arc drum controller when it is advanced to position 2.



The two arc converter machines installed in Annapolis station, showing the benchboards from which the engineer controls the whole station

The cathode or negative electrode of the arc consists of a carbon in a holder, a water cooled sheath which surrounds the holder and removes the heat transmitted to it by the carbon, a mechanism for slowly rotating the carbon and its holder and a means of adjusting the length of the arc gap between the carbon and the copper tip of the anode. The carbon is held in the holder by a split taper collet which is tightened by a small hand wheel called the collet tightening wheel. This construction insures good electrical contact between the carbon and the holder and provides an easy means of making the projecting carbon any desired length. The sheath forms a water jacketed bearing surface within which the holder is rotated. The mechanism for rotating and adjusting the carbon are built as parts of the sheath. A sleeve with jaws which engage similar jaws on the carbon holder is rotated by enclosed worm gears. This sleeve is moved axially to adjust the arc gap by a screw and hand wheel, as shown in an accompanying photograph.

Water for cooling the sheath is supplied by a ¾-inch pipe. After being circulated in the sheath, it goes to the water cooled jacket, which acts as an extension of the chamber and helps keep the cathode cool.

The carbon holder is held in position and locked to the sleeve by a locking wheel and is made removable for renewing the carbon. The carbon may be lengthened without removing the holder from the sheath by unscrewing the plug at the end of the holder, loosening the collet and pushing the carbon forward with the gauge rod provided for this purpose. The carbon may be shortened by simply loosening the collet and turning the adjusting wheel to the right, thereby forcing the carbon against the anode tip and pushing it back in the holder.

The carbon is rotated through enclosed double reduction worm gears by a ¼-h.p., 115-volt direct current motor.

The anode or positive electrode of the arc converter consists of a metal tube with a narrow water cooled copper tip which is renewable; the flame of the arc burns between this copper tip and the carbon electrode of the cathode.

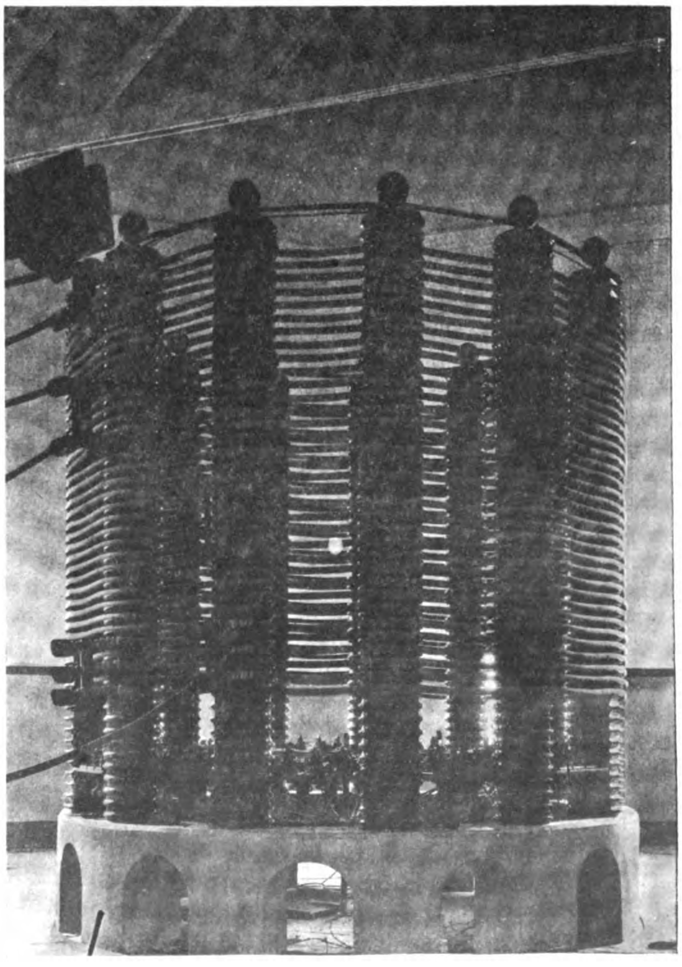
The anode holder is insulated from the frame of the arc converter by a round insulating disc of ebony asbestos. This is placed at the outer end of a water cooled jacket which forms an extension of the chamber. The relatively cool gases in this jacket protect the insulating disc from the heat of the arc flame. The cooling water for the anode is carried to and from it by rubber hose.

It is important that the arc chamber should not be opened after the arc has been in operation until plenty of time has been allowed for the carbon to cool, the chamber is full of combustible gases, which will be ignited by the hot carbon if air is admitted. Two electric Danger signs mounted upon the arc converter which are illuminated whenever the main line contactor is closed and remain lighted after the arc has been shut down until sufficient time has elapsed for the carbon to cool. The lights are controlled by an automatic timing relay.

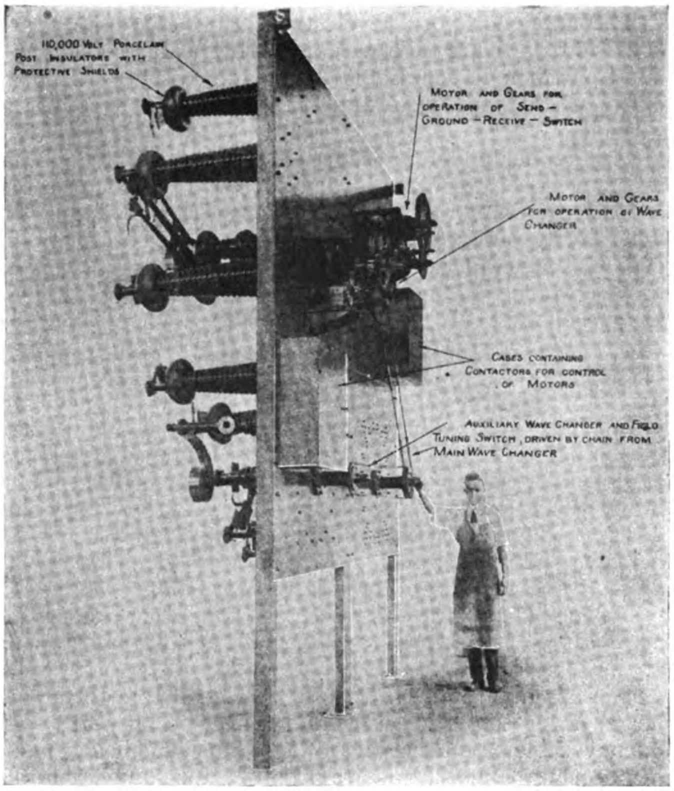
A benchboard located at each arc converter enables the arc engineer to control the whole station from his position at the arc.

The antenna loading inductor is built in the form of a large single layer helix wound with special radio frequency cable upon a series of columns which are made of porcelain rings. Taps are provided for connecting any desired number of turns of this coil in the antenna circuit. Cables connect the proper taps on this loading inductor to the wave changer, which makes the necessary adjustments for five different wavelengths.

The combined wave changer and send-ground-receive switch is a voltage switchboard built with steel panels and



The gigantic helix of the Navy's most powerful wireless station


110,000 Volt Porcelain Post Insulators with Protective Shields
Motor and Gears for operation of Send-Ground-Receive-Switch
Motor and Gears for operation of Wave Changer
Cases containing Contactors for control of Motors
Auxiliary Wave Changer and Field Tuning Switch, driven by chain from Main Wave Changer

Combined wave changer and send-receive ground switch with remote electrical control

porcelain post insulators. The send-ground-receive switch occupies one of the four steel panels which compose the board. The main and auxiliary wave changer switches occupy the other three panels. Both the wave changer and the send-ground-receive switch are of the electrical remote control type, and are controlled by drum controllers on the arc benchboard. Each is driven by a ½ H. P., 115-volt, D. C. motor, through double reduction spur gears. Each motor is controlled through contactors by an automatic switch which is inter-connected with the corresponding drum controller.

The wave changer may be set for any one of five wavelengths by turning its controller on the benchboard to the proper position. Similarly, the send-ground-receive switch may be set upon any of its three positions by placing its controller on the desired notch.

For each of its five positions, the wave changer connects in the antenna circuit the proper number of turns of the antenna loading inductor to give the desired wavelength. It also tunes or adjusts the arc magnetic field to give maximum antenna current and steadiest operation of the arc for each of the five wavelengths.

The main switch arm of the wave changer is mounted upon 110,000-volt. porcelain post insulators, and is operated directly by the motor and gears. The auxiliary switch arms are driven by roller chains which connect them with the gear mechanism of the main switch. In operation, the switch arm on the wave changer short-circuits a portion of the arc field winding to give the proper field strength.

In the Annapolis station the coupled compensation method of signaling is employed. A number of relay keys are connected with a loop system which is inductively coupled with the main antenna loading inductor. Two sets of control relays are provided for the operation of the relay keys. One set is used for high speed sending, and the other set for hand sending. For high speed sending, current for the operation of the relay keys is provided by a special 15 kw., 575-volt generator which is driven by a 220-volt induction motor. For hand sending, 125-volt direct current is used. This is furnished by the 3 kw. motor generators which supply current for the station control circuits and arc auxiliaries.

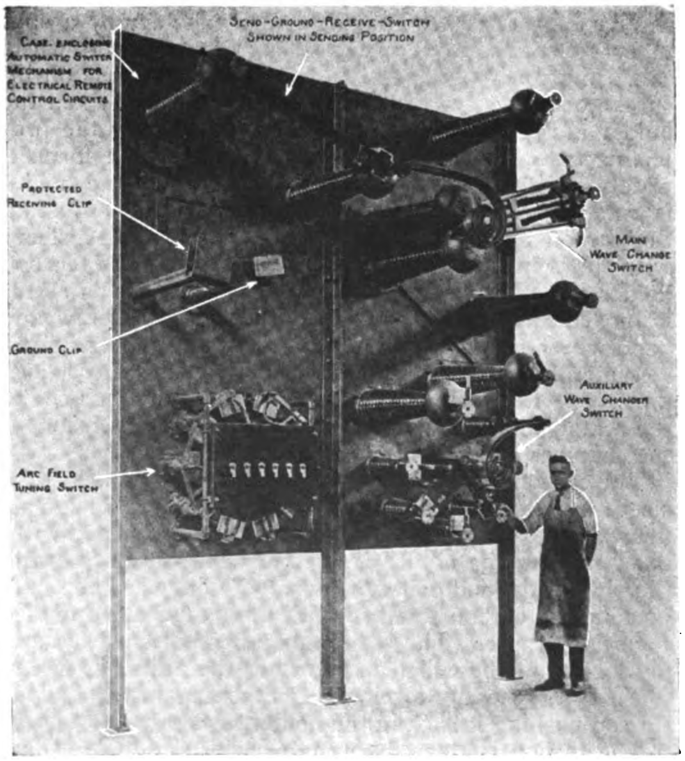
For high speed sending, all of the switches on the transfer panel are thrown toward "high speed sending." The relay keys are then operated in groups of three by 575-volt direct current. Each group of three keys is controlled by one control relay.

The control relays are operated as a group by a master relay using 125-volt direct current. A rheostat behind the switchboard serves to regulate the current which they receive to the value necessary to give the desired speed.

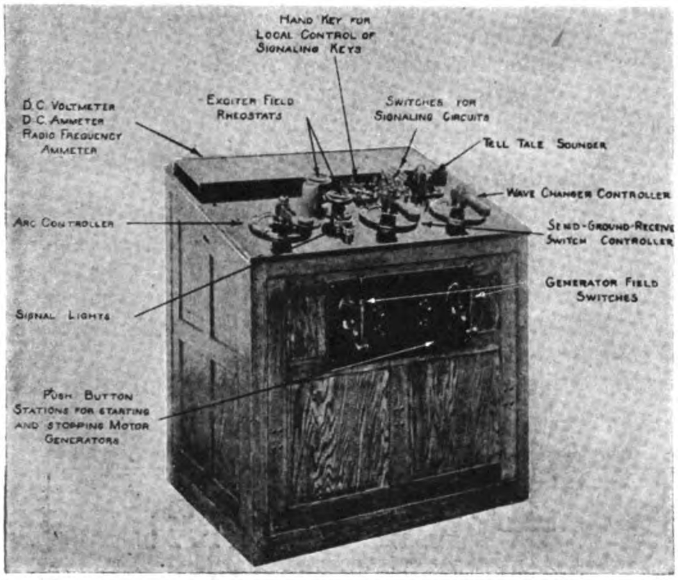
The current which is supplied to the relay keys themselves is regulated by adjusting the spring tension and magnetic air gap of the control relays. A signal light is provided for each control relay, and therefore for each group of three keys. When the keys are operating normally, this signal light burns dimly. In case one of the control relays sticks closed, the signal light burns brightly, indicating that that particular group of three keys is receiving excessive current and its control relay is then adjusted immediately. The signal light goes out in case the control relay sticks open, thereby indicating that that particular group of three keys is not operating.

For hand sending, all of the switches on the relay key transfer panel are thrown toward "hand, sending." All the relay keys are then connected in two main groups, each group being operated by one control relay. The relay keys are then operated by 125-volt direct current. This is supplied through a small contactor which closes whenever the main line contactors are closed. This arrangement prevents current being left in the relay key circuits when the arc is not in use. The two control relays used for hand sending are operated by the same master relay which operates the larger group of control relays used for high speed sending.

Cooling water is supplied to the arc converter through a valve operated by the arc drum controller. This valve is opened on the first two notches of the controller and is therefore turned on whenever the controller is advanced for starting the arc.


Send-Ground-Receive-Switch Shown in Sending Position
Case enclosing Automatic Switch Mechanism for Electrical Remote Control Circuits
Protected Receiving Clip
Main Wave Change Switch
Ground Clip
Auxiliary Wave Changer Switch
Arc Field Tuning Switch

Send-receive ground switch shown in sending position


Hand Key for Local Control of Signaling Keys
D.C. Voltmeter
D.C. Ammeter
Radio Frequency Ammeter
Exciter Field Rheostats
Switches for Signaling Circuits
Tell Tale Sounder
Wave Changer Controller
Arc Controller
Send-Ground-Receive Switch Controller
Generator Field Switches
Signal Lights
Push Button Stations for starting and stopping Motor Generators

Arc control benchboard

The antenna ice melting equipment, by means of which ice may be melted from the wires of the antenna, is operated by a series of switches and utilizes current from the two 400 kw. generators.

During normal operation of the station two switches connect all four of the cables leading down from the antenna loading inductor and thence to the arc. All four of the antenna cables are then connected in parallel, and carry approximately equal amounts of radio frequency current. When it is desired to melt ice from the wires of the antenna, the switches are thrown over to the "ice melting" position, and the four antenna cables are then connected in series. The connections in the antenna itself are such that when the switches are in "ice melting" postion, current will flow through all the various wires of the antenna, heating them and causing the ice to melt.

Circular shields with a large radius of curvature are provided for making connections through the holes in the plate glass antenna entrance windows. The shields furnish charging currents to the glass and prevent corona at high voltage.

The Design of Multi-Stage Vacuum Tube Receiving Circuits

By Lieut. J. Scott-Taggart, M.C.,

Membre de la Société Française des Electriciens

THE present article is intended as an introduction to modern methods of connecting vacuum tubes in cascade for the purpose of receiving wireless signals. Few details regarding such circuits, which are of paramount interest to those engaged in wireless work have been given, and it is proposed to describe some typical practical circuits which have been taken from a complete volume on vacuum tubes by the present author and which will shortly be published by Wireless Press, Ltd., Henrietta Street, London.

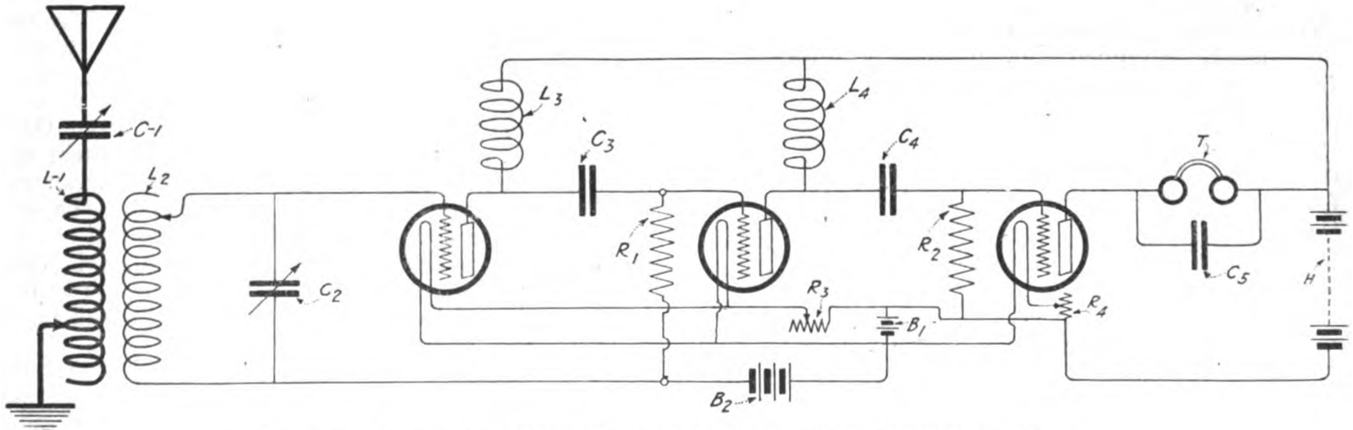


Figure 1—A three-stage amplifier with aperiodic auto-transformer coupling arrangement

All the following circuits possess one common filament battery and one plate battery. A single plate battery may be used provided that its resistance is negligible. The stipulation is that there shall be no resistance common to the plate circuits of several tubes. The voltage applied to the plates of the vacuum tubes is consequently best varied by means of tappings off the battery, and not by means of a variable high resistance in series with the plate battery. Another feature of the amplifier design is that all the vacuum tubes used as amplifiers are adjusted to the same operating point. The plates of all the amplifying tubes are given a fixed voltage which is variable if desired. A single rheostat (of about 5 ohms resistance) serves to adjust the filament currents of all the valves simultaneously. Likewise, since all the tubes are of identical construction and carry out the same functions, a single potentiometer to control simultaneously the grid potentials of all the amplifying vacuum tubes can be used. This potential is preferably negative and in the neighborhood of 2 volts.

Cascade amplifiers may roughly be divided into four classes.

(1) High frequency amplifier-detectors, which use several tubes as oscillation amplifiers and a final tube as a detector.

(2) Amplifiers similar to the above, in which the de-

tector valve is followed by one or more stages of low-frequency amplification.

(3) Amplifiers in which the first vacuum valve acts as a detector, the succeeding tubes operating as low-frequency amplifiers.

(4) Amplifiers in which the oscillations are magnified by a number of tubes and then rectified, the rectified pulses being now led back to one of the preceding tubes and re-amplified by the system at low frequency.

Each of the above four types may be provided with arrangements for producing regenerative amplification or self-oscillation (the latter for continuous-wave reception). Here again the amplifiers may be modified by different methods of obtaining regeneration such as:

(1) The use of magnetic couplings, direct or indirect.

(2) The use of capacitative coupling.

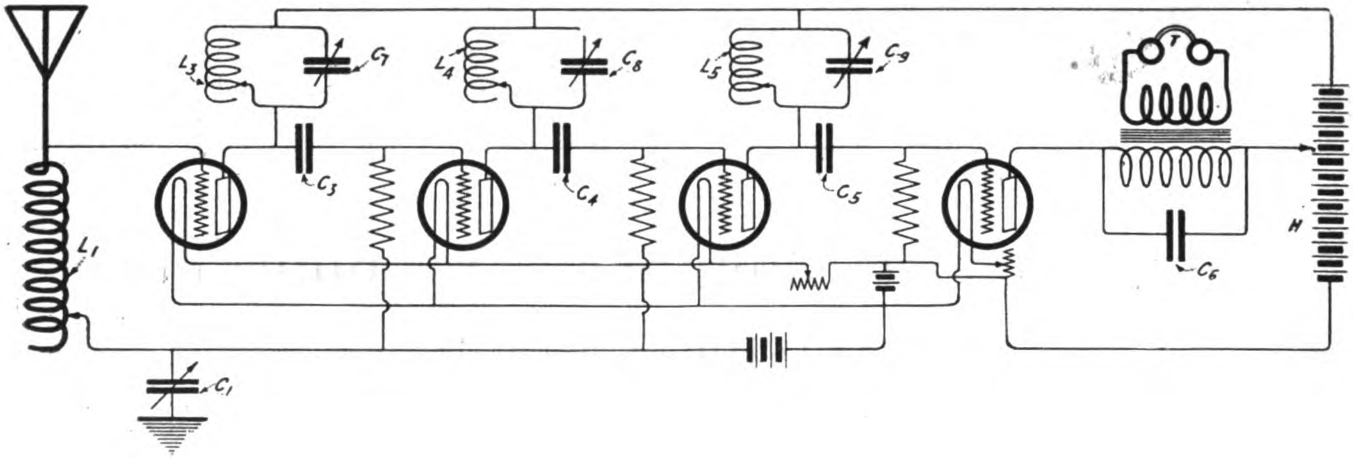


Figure 2—Four-stage amplifier-detector with tuned intermediary auto-transformer

(3) The use of resistance or conductive coupling.

Another matter of utmost importance in the design of multi-stage amplifiers is the means to be adopted for coupling the output circuit of one tube to the input circuit of the next. One or other of the following methods is usually used:

1. (a) Aperiodic air-core auto-transformers.
   (b) Tuned air-core auto-transformers.
   (c) Air-core auto transformers with aperiodic plate circuit and tuned grid circuit (or vice versa).
2. (a) Aperiodic air-core oscillation transformers.
   (b) Oscillation transformers having aperiodic plate circuit and tuned grid circuit (or vice versa).
   (c) Completely tuned air-core oscillation transformers.
3. Use of coupling resistances.
4. Employment of impedance coil couplings.
5. (a) Aperiodic iron-core auto-transformers of fixed ratio.
   (b) Similar transformers with step-up ratio.
   (c) Above transformers resonated to give frequencies.
6. (a) Aperiodic step-up iron core transformers.
   (b) Tuned iron-core transformers for low frequency amplification.
7. Iron-core transformers as described in classes 5 and 6, but designed for high frequencies.

Each of these systems of couplings has its advantages and disadvantages. The complicated circuit, while giving excellent results in the hands of an expert, is obviously unsuitable for use by the average operator. The design of amplifier chosen will depend on the following conditions:

(1) Whether the apparatus is to be handled by an expert or an inexperienced operator.

(2) Whether it is to be portable or not.

(3) Whether it is for general reception on a wide range of wavelengths or only on one wavelength.

(4) Whether the apparatus is to allow of many adjustments or as few as possible.

(5) Whether it is for experimental or commercial work.

(6) The degree of amplification desired.

(7) Whether loud signals or weaker signals with less interference are desired.

(8) Whether the circuit is intended for the reception of weak or strong signals.

(9) Whether the circuit is to be used for the reception of continuous waves or not.

(10) Whether the amplifier is to be used for the reception of short waves or long waves.

These questions must first be answered before commencing the design of a multi-stage vacuum tube receiving circuit. It is now proposed to describe typical amplifiers of each of the seven classes and to show some of the various modifications which are possible. Each of the above ten questions should be applied to the circuit under discussion. By doing this a suitable circuit is evolved having just those characteristics and modifications which are necessary to make it carry out the duties required of it. Figure 1 shows a three-stage amplifier having aperiodic inductances L-3 and L-4 connected as shown. The received oscillations are amplified by the first tube, the magnified high frequency current flowing via L-3 and the plate battery H. The oscillating potentials at the foot of L-3 are communicated to the grid of the second tube through the condenser C-3 of about .0003 mfd. capacity. If the condenser C-3 was omitted, the potential of H would give the grid of the second vacuum tube a high and undesirable positive potential. The second vacuum tube now amplifies the oscillations a second time, the magnified potentials at the foot of L-4 being communicated through C-4 to the grid of the third tube, which is arranged to act as a detector, the telephone T being connected in the plate circuit.

The first two tubes act as oscillation amplifiers and are arranged to work on straight portions of their plate and grid current curves. Their grid potentials are the same and are given a suitable negative value by means of the battery H-2, consisting of one or two cells. The second grid receives its potential through the resistance R-1 of from 2 to 5 megohms. Since the grid is negative there is practically no grid current. Consequently there is no fall in potential across R-1 in spite of its high resistance. This use of the resistance R-1 and battery B-2 is very useful in all amplifiers using auto-transformer, resistance or impedance couplings.

The rheostat R-3 (of about 5 ohms resistance) is used to vary the current supplied by the accumulator B-1 to the filaments of the two amplifying tubes. A separate rheostat R-4 is used to vary the filament current of the detector valve which requires a different adjustment to that of the amplifying tubes. The resistance R-2, having about the same value as R-1, acts in a manner similar to the leak across a leaky grid condenser. It prevents an excessive negative charge from building up on the grid of the third valve. The foot of R-2 might, if desired, be connected to the negative side of B-1. If instead of desiring to use grid current rectification it were desired to work on one of the bends of the plate current curve it would be possible to include a potentiometer between the foot of R-2 and the battery B-1. A suitable operating point on the saturation bend may, however, be most easily obtained in a circuit similar to figure 1 by adjusting R-4. (J. Scott-Taggart "On Valve Characteristic Curves and Their Application in Radiotelegraphy," WIRELESS WORLD, Sept., 1918).

The inductances L-3 and L-4 should have a natural wavelength less than the wavelength to be received. If the range of wavelengths to be received is wide, tappings may be taken from L-3 and L-4.

Figure 2 shows a modification of the figure 1 circuit. Four vacuum tubes are shown in use. The first three act as amplifiers and the last as a detector. The intermediary inductances L-3, L-4 and L-5 are tuned by the aid of variable condensers C-7, C-8 and C-9. The circuit as it stands is capable of much finer tuning than figure 1, each plate oscillatory circuit requiring to be tuned to the incoming waves, whereas the figure 1 circuit will respond to a wide range of wavelengths without adjustments of the amplifier circuits. In the plate circuit of the last valve is the primary of the step-down telephone transformer. Across this winding is connected a condenser C-6, which, like C-5 of figure 1, allows the passage of the comparatively strong high frequency component of the rectified current in the plate circuit without injuring the windings. Another feature is the use of a separate tapping, which allows the plate voltage of the detector valve to be independently regulated.

(To be continued.)

Some Recent Developments in Radio Transmitters

By Morton W. Sterns

DUE to the impetus of the war many and various were the types of transmitters that were developed. Of these many have been described in current periodicals, but nothing at all has been published, to the writer's knowledge, on a very interesting phase of the subject, viz.: the utilization of direct current for transmission without the use of vacuum tubes, Chaffee gaps, arcs, etc.

As is well known, at the outbreak of the war the government asked for samples of transmitters of various kinds, mainly for aeroplane use, giving only very general specifications as to space, weight, antenna capacity, etc., and allowing the various manufacturers to use their own judgment as to type. From the original samples thus produced the present types were developed, which incorporate also the changes found advisable in service.

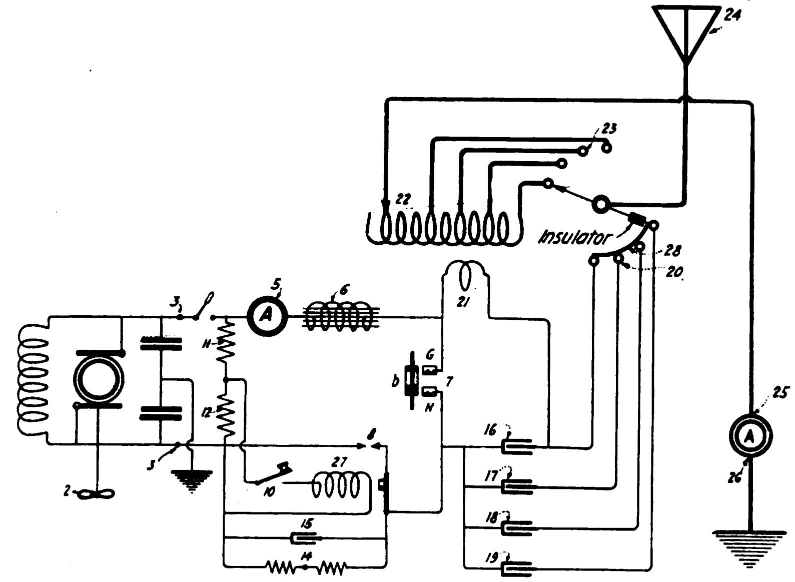


Figure 1—Wiring diagram for airplane radio buzzer set design by Sperry Gyroscope Co.

Among the sets submitted was a direct current buzzer set manufactured by the Sperry Gyroscope Company, illustrated in figure 3. From this original sample a rather complete line of buzzer transmitters of various powers and for various conditions were developed.

It may not be amiss to look into the advantages of the buzzer type transmitter. First, it is very simple in construction and is easy to manipulate; second, it eliminates the use of high potentials, thus simplifying insulation problems; third, it is fairly efficient—ranking quite well with other types of sets; fourth, its extreme simplicity makes it very easy to understand and operate.

A schematic wiring diagram of the buzzer transmitter in its simplest form is shown in figure 2.

To follow its operation imagine the key to be depressed, the current will then flow from the direct current source through the choke coil into the movable spring D, to the stationary contact C and thence back to the source. When current traverses the choke coil winding it becomes a powerful magnet and attracts the iron armature on the movable spring D, which moves over toward the magnet core and opens the circuit at the contacts C, D. Immediately the current ceases to flow in the electro-magnet (choke coil), and, since the magnet no longer attracts the armature of D, the movable spring D returns to its normal position, due to the bending force it was under. This immediately causes current to flow again in the magnet winding, and the same cycle of operation takes place as long as the key remains depressed.

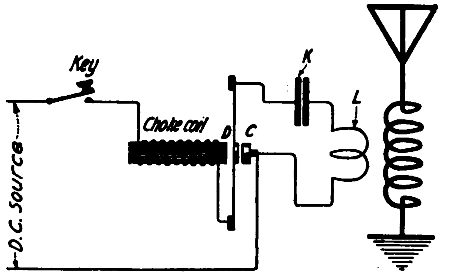


Figure 2—Schematic wiring diagram of the buzzer transmitter

When the magnet coil causes the circuit to be broken at the contacts C, D, an excessive instantaneous voltage is produced across the gap C, D, due to the inductive kick of the choke coil, and this voltage charges the condenser K in the high frequency circuit CDKL, which in turn discharges across the now open gap and sets up highly damped oscillations in the circuit CDKL and impulses the closely coupled antenna circuit into oscillation at whatever frequency it happens to be tuned to.

If L be the inductance of the coil in henries and I be the current flowing through the coil in amperes, then the voltage across the coil at the instant the current is broken is equal $\frac{1}{2}$ LI^2, and this voltage is also effective across the gap CD and tends to charge the condenser K.

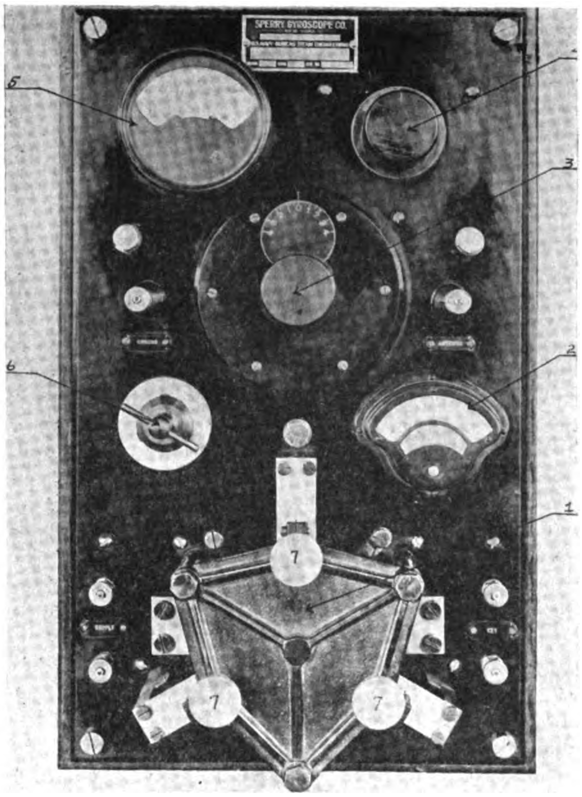


Figure 3—Front view of 500-watt, 500-volt buzzer transmitter

Since the energy stored in the condenser is equal to ½ CE² it is seen that in order to get maximum output we must use the largest capacity condenser consistent with the wavelength. Using a large capacity condenser fulfills two necessary conditions simultaneously, viz., the elimination of sparking at the contacts C, D and causing a preponderance of capacity with only enough inductance in the high frequency circuit CDKL to efficiently transfer the energy from primary to secondary. This is the ideal condition for an oscillation circuit to rapidly damp out after one or two oscillations and impulse a secondary circuit.

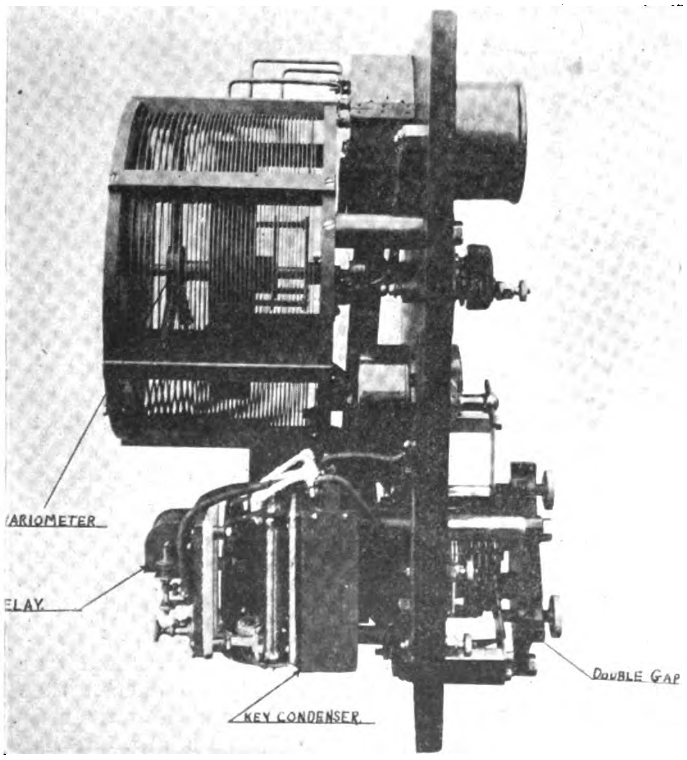


Figure 4—Side view of figure 3, showing arrangement of instruments

The radiation produced by the larger type sets, to be described and illustrated in figure 3, have a rather low note and the wave characteristic is somewhat between a pure undamped wave and a damped wave, so that a receiver of either the usual crystal type or the heterodyne receiver could not get the maximum audibility from its signals. However, since the radiation was good, and since excess of energy existed to work with this slight disadvantage, it was felt it could be overcome. After some experimentation I discovered that by placing a rotary chopper on the antenna circuit I could modulate the emitted envelope and produce notes of absolute purity which, while decreasing the radiation slightly, greatly increased the working range due to its absolute tone characteristics. The note could be varied at the will of the operator by simply changing the speed of the chopper motor, which controlled the rapidity of interruption. It is interesting to note that the use of the chopper was not needed on low power sets.

The oscillations produced by this type of set are almost of the impact excitation type, and to change the wavelength of the emitted wave for ranges of a few hundred meters, the primary may be set at one wave and the inductance in the open circuit may be varied. For large ranges of wavelength, such as is shown in figure 10, where seven wavelengths varying from 600 to 2,400 meters are used, it is policy to vary the capacity of the primary condenser for every two or three wavelengths, although the maximum radiation is seldom produced when the primary and secondary circuits are in tune.

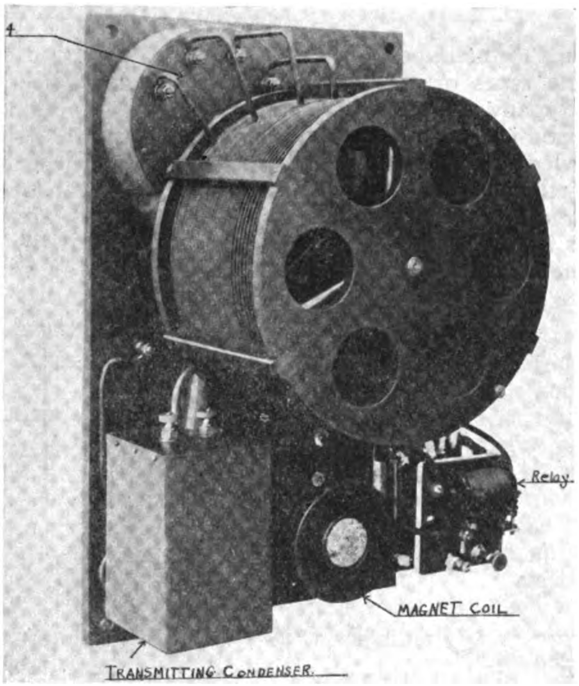


Figure 5—Rear view of figure 3, showing the helix, relay key, coil and condenser

A brief description of the three standard type buzzer transmitters manufactured by the Sperry Gyroscope Company will now be given.

Referring to figure 10 we see a very small type 75-watt set which operates on 110 volts D. C. Its dimensions are approximately 7 x 12 x 5 inches, and the whole outfit can be readily held in one hand. It was originally designed for airplane use, but eventually an even more compact set of the same type was developed and these first sets were installed on small boats.

On a submarine chaser antenna these sets give a radiation of about 2 amperes on all wave lengths. On a 250-foot trailing wire from an airplane a radiation of 1.25

amperes was obtained and a very strong signal was obtained at a distance of 18 miles.

Referring to figure 10, the wave changer appears at the top of the panel. This wave changer allows a selection of seven wavelengths between 600 and 2,400 meters to be rapidly made. Under the bakelite button at the switch centre is a fan contact which automatically connects in various values of the primary condenser as explained above. Underneath is the antenna and ground binding posts and the hot wire radiation ammeter. Below the ammeter is the buzzer gap which is constructed somewhat after the fashion described in my article in the July Wireless Age. The arrow points to the vibrating contact. The top of the stationary contact can be seen extending from its casting and shows the method of adjustment. At the bottom of the panel are the terminals for the supply and key. In the rear of the panel behind the wave changer are mounted the pan-cake oscillation transformers wound with large size litzendraht and tapped for the various wavelengths. The primary consists of about three turns. The key and oscillation condensers are mounted in one case behind the ammeter and naturally the magnet coil is mounted behind the gap casting.

The front view of the original type of buzzer transmitter submitted to the government at the outbreak of war is shown in figure 3. This type of equipment was manufactured in large quantities and furnished to both the Navy and Signal Corps. It is a 500-watt 500-volt set and furnishes a radiation of 4.5 to 5 amperes on a 300-foot trailing antenna as used on airplanes.

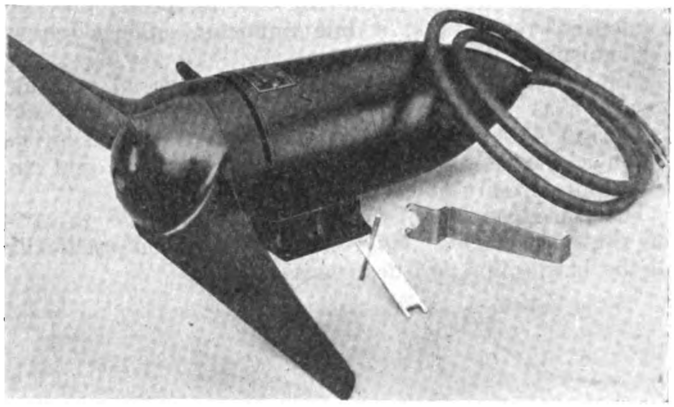


Figure 6—Wind driven generator equipped with self-regulating propeller blades

While these sets were designed primarily for airplane use they were eventually used for ground telegraphy and on training planes, being superseded by more compact types for airplane use.

Referring to figure 3, the hot wire radiation is shown at 5, while 4 shows the wave changer which has the four standard navy waves, namely, 300-378-476-600 meters. Number 3 indicates the antenna variometer adjustment, which allows the wave to be corrected for changes in antenna capacity due to flying low or having part of the antenna reeled in. The scale above the adjustment knob shows the number of turns added or subtracted from the antenna circuit. A total variation of 25 meters is possible with the variometer. Another view of the variometer and a side view of the set is shown in figure 4.

On either side of the variometer handle are mounted the insulated binding posts for antenna and ground.

The main switch which turns the power on or off is shown at 6, while number 2 represents the direct current ammeter in the power circuit.

Number one is the gap, showing the adjusting screws 7. On either side of the gap are the supply and key terminals.

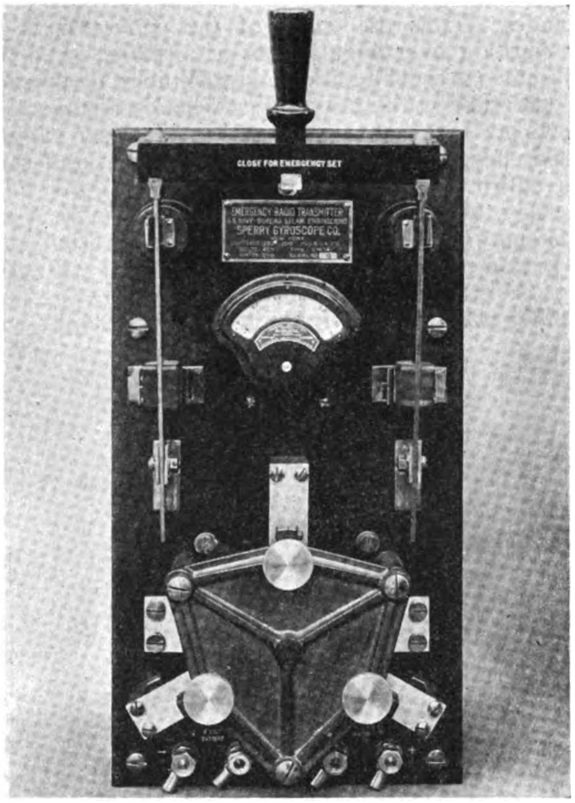


Figure 7—Front view of the emergency radio transmitter

Figures 4 and 5 show a side and three quarter view of the set and give details of the various condensers, helix and relay key.

Figure 6 shows the 500-watt 500-volt wind driven generator furnished with the set, also the necessary wrenches for dissembling the generator. This illustration shows the original type fan with a manually operated brake to approximate constant speed regardless of the maneuvers of the airplane. As is well known, if the plane takes a nose dive the generator speeds up and develops such an excessive potential that damage may ensue. For this reason most of the sets are equipped with self-regulating fans. When the speed of the airplane increases and consequently the speed of the generator, a centrifugal regu-

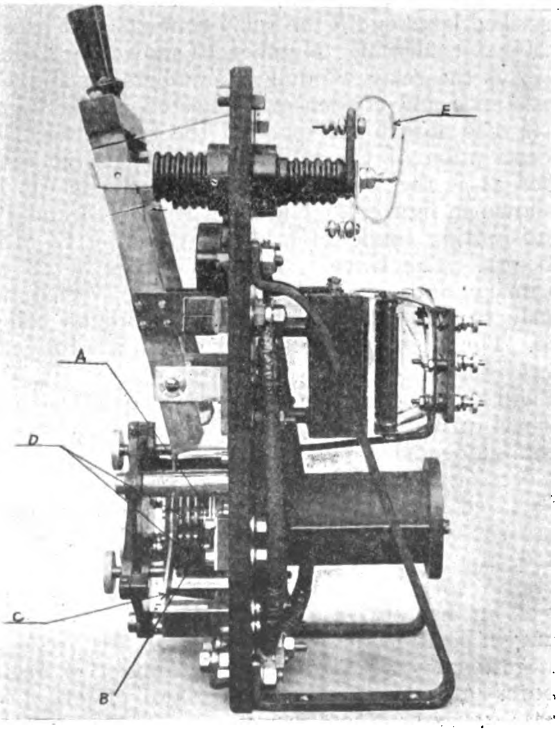


Figure 8—Side view of the emergency set designed for use on shipboard

lator flies out and automatically alters the pitch of the fan blades. Thus the speed of the generator is kept fairly constant over wide ranges of airplane speed.

All controls are fitted with large knobs to permit of their operation by the heavy-gloved hands of the aviator. All parts are fastened so as not to loosen under vibration. The switches must all be pulled out to turn and cannot be moved by vibration.

The key, mounted on an insulated piece with a strap for fastening on the leg of the operator, is fitted with a large button to allow the operator to work it with gloves on.

In order not to put the full potential of 500 volts on the leg of the operator two resistances Nos. 11 and 12 are connected across the line and the fall of potential across resistance 12 in diagram B, which is equal to about 100 volts, operates the relay. Thus if the insulation of the key should break down there would never be more than 100 volts near the operator and his glove would protect him from that.

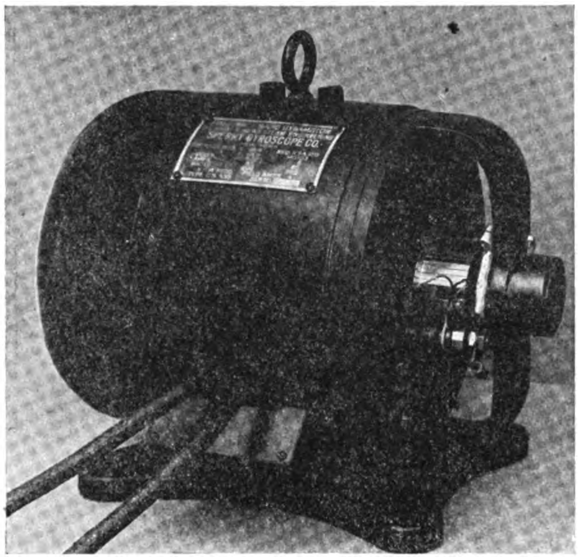


Figure 9—Two-pole semi-enclosed dynamotor which operates on a 6-volt storage battery

Referring to figure 1, No. 2 represents the air driven shunt wound generator. No. 3 shows the kick-back preventer condensers, 4 the main switch, 5 the D.C. ammeter, 6 the magnet coil, 7 the double buzzer gap to be described later and 8 the relay contacts that break the main 500-volt current. Number 10 shows the hand key, while 27 is the relay winding. Numbers 14 and 15 are the resistance and condenser connected across the relay contacts 8 to absorb the spark at the relay break.

A description of the high frequency circuit follows: Number 21 is the single turn primary inside the helix. It is shown in figure 4. Numbers 16, 17, 18 and 19 are the transmitting condensers, with a value of .12 M.F. on 600 meters. The wave changer is shown at 28 where the primary and secondary circuits are varied simultaneously from the one knob, the two circuits being insulated. The taps in the secondary circuit are fully shown in figures 4 and 5.

We will now take up the construction of the spark gap 7 which is in reality two gaps in series but arranged to open simultaneously.

The oscillating member of the gap consists of a copper disc 7b faced heavily with silver. This copper block is carried in a recess of the cooling block. The whole is mounted on a flat spring which is actuated by the electro magnet. A soft iron disc serves the double purpose of acting as an armature for the magnet and as a nut for clamping in position the oscillating gap.

The stationary gap is divided, forming two insulated electrodes, 7g and 7h. The current thus enters through terminal 7g, passes across the gap toward the panel, then down through the vibrating electrode, back across the gap in the opposite direction, and out of the terminal 7h.

One of the essential requirements of this type of gap is that the surfaces be parallel, and in order to make this parallelism a matter of easy adjustment the construction shown was used.

The stationary gaps are mounted on and insulated from an inverted Y spring carried on high standards. Now on each prong of the Y, midway between the centre and the supports, an adjusting screw, 7, figure 3, bears. By turning down any one of these screws, the face of the stationary gap will be tilted down in that direction. By turning down all the screws equally, the entire stationary gap may be moved into contact with the vibrating gap. The pressure of this contact determines the power input. This construction is fairly well shown in figure 8.

Here A is the vibrating contact 7b, B is the vibrating spring. D shows the stationary gaps 7g and 7h. C is the inverted Y spring.

The size of this airplane set is 12 inches wide, 20 inches high and 10¼ inches deep. Its weight is approximately 50 pounds.

The Sperry Type CS 494 Emergency Radio Transmitter is designed for use on shipboard, as an emergency set, when power from the main supply is cut off.

It operates on a 6-volt storage battery through the medium of the dynamotor which delivers 400 volts D. C. to the transmitter. Figures 7 and 8 show the transmitter, while figure 9 shows the dynamotor.

The transmitter is of the vibrating gap type with a capacity of 200 watts continuous sending. It is mounted on a bakelite panel 9½ inches wide by 20 inches high. The panel also carries all terminals, binding posts, the key condenser, resistances, a line ammeter and switching mechanism.

The dynamotor is a two pole, semi-enclosed machine operating as a motor from a 6-volt storage battery, and delivering 400 volts direct current to the transmitter. The machine is entirely fitted with ball-bearings and has an output capacity of 200 watts.

There are over 250 of these transmitters in use on various ships of the navy today—being installed on practically all the battleships and destroyers.

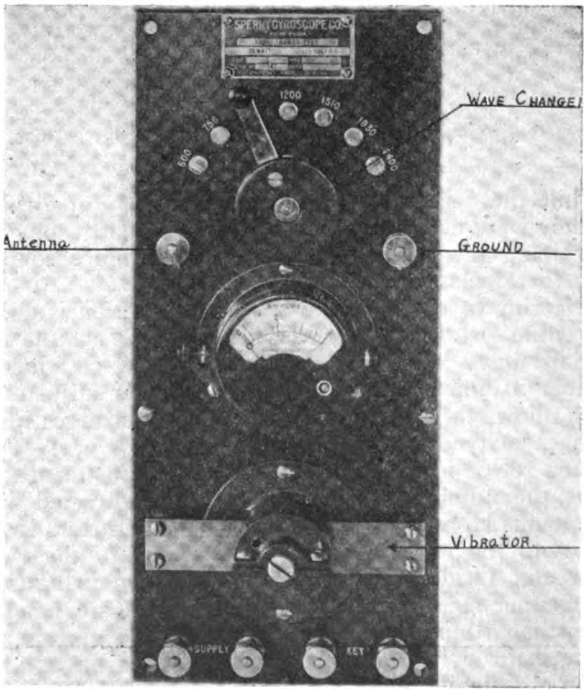


Figure 10—Small type 75-watt buzzer transmitter

This transmitter is intended for emergency use and operates in conjunction with the standard wave-changer of the main radio set and its condenser.

Radio Frequency Interference Balance

THE effect of static disturbances upon a receiving system may be likened to that of a blow upon a tuning fork. Characteristic damped oscillations of the natural frequency of the system are set up therein and these cannot be tuned out as can persistent or sustained oscillations of a definite periodicity from a foreign station. In the present arrangement no attempt is made to tune out the interference known as "static" but an auxiliary system is provided whose function is, in co-operation with the receiving system, to balance out or neutralize static disturbance with respect to the receiving device. The auxiliary system is tuned and is therefore unresponsive to the continuous waves it is desired to receive. The natural oscillations excited by static disturbance in the receiving and auxiliary systems are therefore of different frequencies. For this reason a frequency converting device is provided to convert the frequency of the oscillations in the auxiliary system to the same frequency as that of the oscillations in the receiving system and differentially combine the resultant oscillations with respect to the receiving device. A further feature of the idea consists in providing an auxiliary system whose characteristic damping factor is the same as that of the receiving system. The arrangement is best understood by reference to figures 1, 2 and 3, which are diagrams illustrative of three forms of wireless receiving systems embodying the invention. Referring to figure 1, a pair of receiving antennae are provided, antenna 1 being tuned to the receiving frequency and antenna 2 being tuned to a frequency differing sufficiently therefrom to render it unresponsive to the receiving frequency. Coupled to antenna 1 by a transformer is an oscillation circuit tuned to the receiving frequency and working into the input side of a vacuum tube amplifier of the usual construction. Similarly, antenna 2 is connected by means of a transformer to an oscillation circuit tuned to the same frequency as its antenna and working into the input side of a second vacuum tube amplifier. A frequency transformer 9, of the Goldschmidt type is provided, this transformer comprising a rotor winding 10, and stator and field windings 11 and 12, winding 11 being included in the output circuit of amplifier 8. The rotor winding is connected to the input side of a modulator whose output circuit works through a transformer into an oscillation circuit connected to the input side of a vacuum tube detector in the output circuit of which is a receiving telephone.

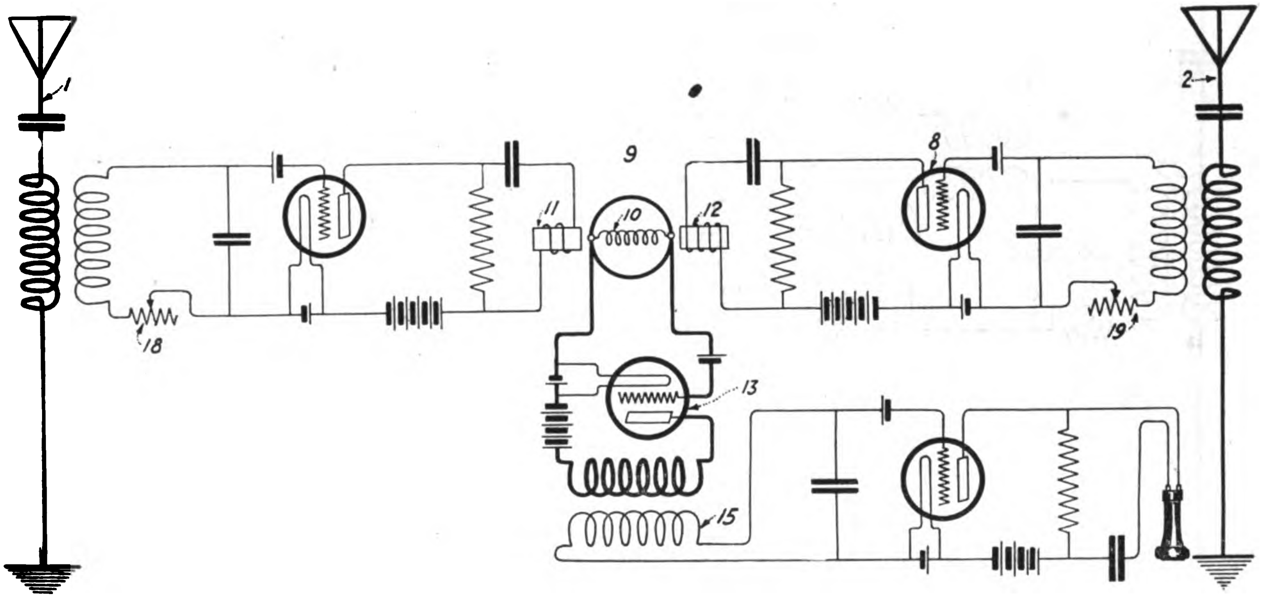


Figure 1—Diagram of a receiving system having two antennae used to neutralize static disturbances

The frequency transformer above referred to is so constructed that its rotor winding may be rotated at a speed such as to give an alternating frequency n. If then, a frequency N be impressed upon its stationary winding 11, it may be shown that two frequencies $N+n$ and $N-n$ will appear in the rotor circuit while if a frequency N_1 be impressed on winding 12, frequency N_1+n and N_1-n will appear in the rotor circuit.

Suppose a static disturbance affects both antennae and that these antennae are resonant to frequencies N and N_1 respectively. Antenna 1 will oscillate at frequency N and impress oscillations of the same frequency upon its oscillation circuit, these oscillations being amplified by the amplifier and impressed in the field winding 11. At the same time antenna 2 oscillates at frequency N_1 and impresses this frequency upon its oscillation circuit, these oscillations being amplified by the connected amplifier and impressed upon the field winding 12. If now the rotor be rotated at an alternating frequency n, so chosen as to be equal to ½ (N—N) three frequencies will appear in the output circuit, namely $N+n$, $N-n=N_1+n$ and N_1-n. These frequencies are amplified by amplifier 13 and impressed upon oscillation circuit 15 which is tuned to frequency $N-n=N_1+n$ so that this frequency is brought out and frequencies $N+n$ and N_1-n are suppressed. The circuits may be so adjusted that the oscillations from both antennae are impressed upon their respective stator windings in such a manner as to appear in the rotor circuit in opposite phase relation, while by suitable adjustment of their respective amplifiers the oscillations may be given the same amplitude, and by means of variable resistances, the same decrement. Being converted to the same frequency by the frequency transformer it is obvious that the two sets of oscillations will then neutralize each other and that no oscillations will appear in the oscillation circuit and no effect will be produced on the detector or the receiving instrument. If, however, signals of a frequency N are received the antenna 2 is substantially unaffected while the antenna 1 being resonant to this frequency impresses said frequency through the amplifier upon field winding 11. As a result, frequencies $N+n$ and $N-n$ appear in the rotor circuit and are amplified by amplifier 13. The oscillation circuit suppresses the frequency $N+n$ while frequency $N-n$ is impressed on the detector and gives a signal in the receiving instrument. It is obvious that the rotor circuit may be tuned to the desired frequency $N-n=N_1+n$ so that the undesired frequencies $N+n$ and N_1-n are suppressed before amplification by amplifier 13, in which case the oscillation circuit 15 would be unnecessary. It will further be noted that by the provision of resistances 18 and 19, the auxiliary circuits, including antenna 2 and associated circuit may be adjusted so as to have the same damping factor as the receiving circuits so that static disturbances produce oscillations of the same damping in both sets of circuits.

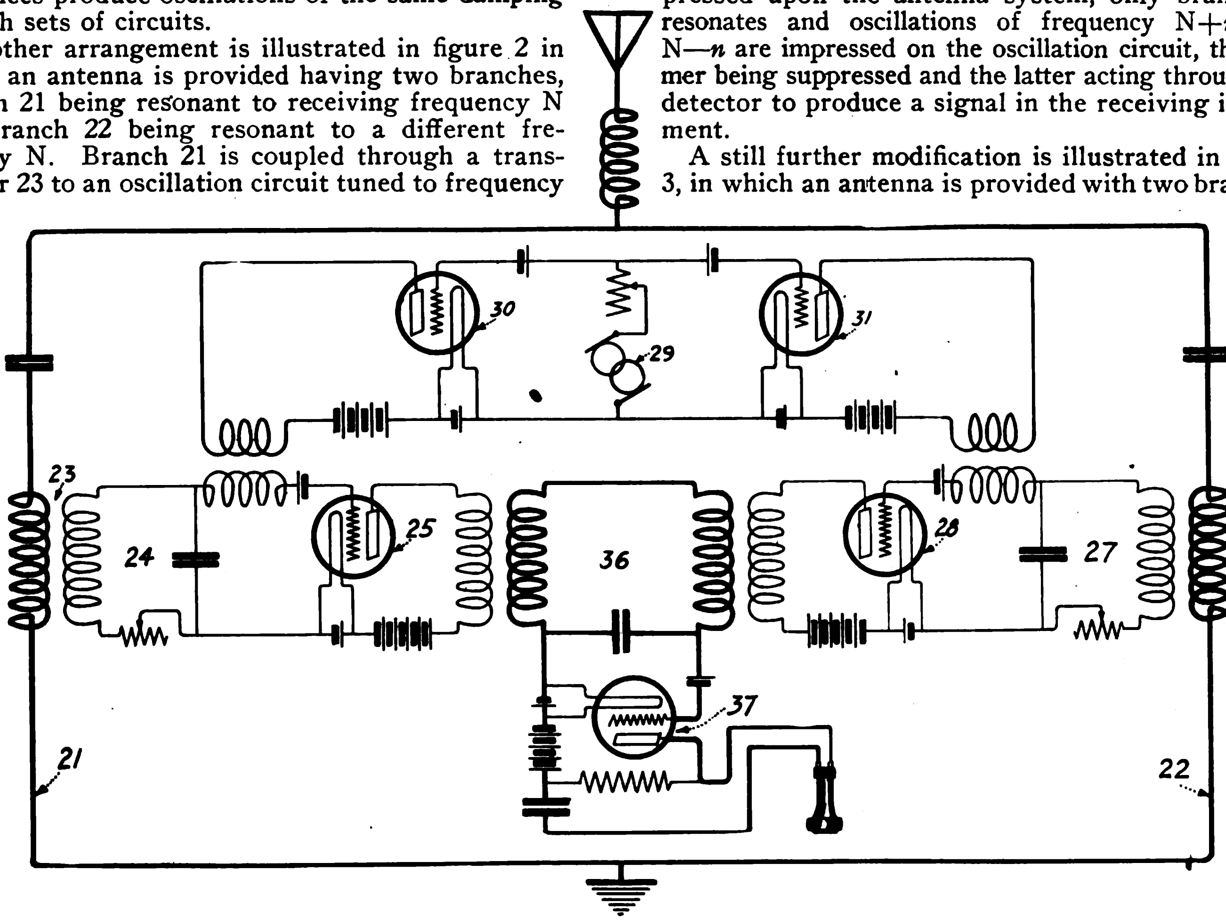


Figure 2—Diagram of a system having one antenna with two branches resonant to different frequencies

Another arrangement is illustrated in figure 2 in which an antenna is provided having two branches, branch 21 being resonant to receiving frequency N and branch 22 being resonant to a different frequency N. Branch 21 is coupled through a transformer 23 to an oscillation circuit tuned to frequency N and connected to the input side of a vacuum tube modulator. Similarly branch 22 is coupled through a transformer to an oscillation circuit tuned to frequency N_1 and working into the input side of a vacuum tube modulator. A generator 29 of frequency *n* is connected to the input side of vacuum tubes 30 and 21, whose output circuits are connected through transformers to the input circuits of modulators 25 and 28 respectively. These vacuum tubes prevent any reaction from the input of the modulators back into the generator. The output circuits of modulators 25 and 28 work through transformers into an oscillation circuit 36 tuned to frequency $N-n=N_1+n$, said circuit being connected to the input circuit of a detector in the output circuit of which is a receiving instrument.

When a static disturbance occurs the antenna branches resonate at frequencies N and N_1 respectively so that a frequency N is impressed on the modulator from the oscillation circuit 24 and a frequency *n* is also impressed thereon by the generator and consequently frequencies $N+n$ and $N-n$ appear in the output circuit of the modulator. At the same time a frequency N, is impressed on the modulator from oscillation circuit 27 while a frequency *n* is impressed thereon from the generator 29, so that frequencies N_1+n and N_1-n appear in the output circuit of the modulator. These several frequencies are impressed upon oscillation circuit 36 through transformers and if, as in figure 1, $N-n$ is equal to N_1+n and oscillation circuit 36 is tuned to this frequency, frequencies $N+n$ and $N-n$ are suppressed and only frequency $N-n=N_1+n$ is impressed on detector 37. As the circuits are adjusted so that oscillations of frequency $N-n$ and N_1+n are impressed upon oscillation circuit 36 in opposite phase relation and with equal amplitude, no effect is produced upon the detector or receiving instrument. If, however, signals of frequency N are impressed upon the antenna system, only branch 21 resonates and oscillations of frequency $N+n$ and $N-n$ are impressed on the oscillation circuit, the former being suppressed and the latter acting through the detector to produce a signal in the receiving instrument.

A still further modification is illustrated in figure 3, in which an antenna is provided with two branches resonant to frequency N and N_1 respectively, branch 40 being coupled through a transformer to an oscillation circuit tuned to frequency N, and branch 44 being coupled through a transformer to an oscillation circuit 45 having a natural frequency N. Circuit 43 is connected to the input side of an amplifier whose output circuit is coupled through a transformer to the input circuit of a modulator while circuit 45 is connected to the input side of an amplifier whose output circuit is coupled through a transformer to circuit 48. A generator comprising a vacuum tube having an oscillation circuit has its circuit arranged in a manner so as to generate oscillations of frequency *n* in the oscillating circuit 53, which is coupled through a transformer to circuit 48. Frequencies N, N_1 and *n* being impressed upon this circuit, it may be shown that frequencies $N+n$, $N-n$, N_1+n and N_1-n will appear in the output cricuit of the modulator, said circuit being coupled through a transformer to oscillation circuit 56 resonant to a frequency $N-n=N_1+n$. The input side of a detector is connected to an oscillation circuit and a receiving instrument is included in the output circuit of the detector.

If, now, a static disturbance occurs, branches 40 and 44 resonate at frequencies N and N_1 respectively, these frequencies being amplified by amplifiers and impressed on circuit 48 together with frequency *n* from the generator so that frequencies $N+n$ and N_1+n will be of the same amplitude and in opposite phase relation. Oscillation circuit 56 suppresses frequencies N+*n* and N_1+n and as the oscillations of frequency N—*n* and N_1+n are of the same frequency and amplitude but opposite in sign, these frequencies neutralize each other in the oscillation circuit so that no effect is produced on the detector or receiving instrument. If, however, a signal of frequency N is impressed on the antenna systems, branch 40 resonates while substantially no effect is produced on branch 44. Frequency N is therefore amplified by amplifier 16 and impressed on circuit 48 together with frequency *n* from the generator so that frequencies N+*n* and N—*n* appear in the output circuit of the modulator, the former being suppressed by the oscillation circuit and the latter being impressed on the detector to produce a signal in the receiving instrument.

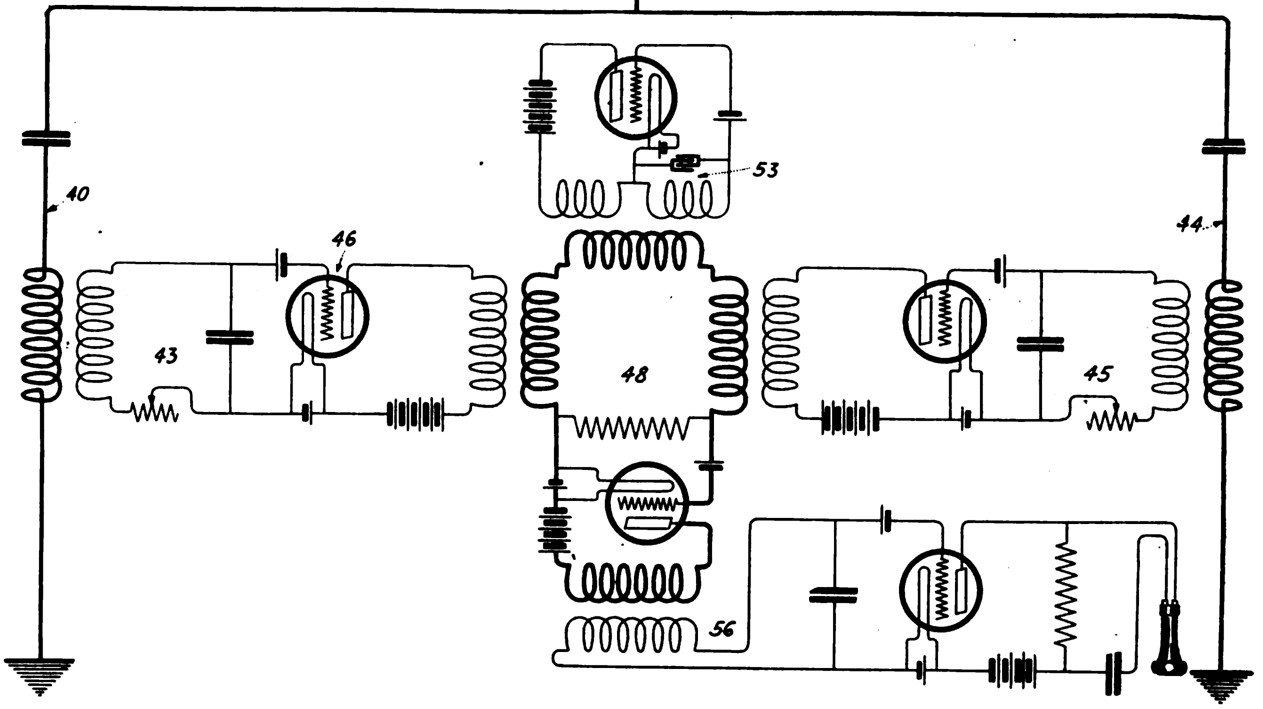


Figure 3—Another circuit used to secure radio frequency interference balance

Radiophone Modulator

LEE DE FOREST has devised a means of modulating radio frequency currents in accordance with the sound vibrations produced by the voice, these currents being of a greater order of magnitude than it would be possible to modulate with the ordinary telephone microphone. He has discovered that if a portion of the inductance which is in the antenna circuit is shunted by a microphone and the microphone actuated by the sound vibration produced by the voice, that the wave-length of the transmitted energy will be varied in accordance with the variations of the voice vibrations and that the energy received at a receiving station will therefore vary in accordance with the variation of the voice vibrations. Figure 1 shows several microphones actuated in phase, each microphone being in shunt to a portion of the inductance in the antenna circuit. It is apparent with reference to the figure that a considerable effect upon the wave-length of the transmitted energy may be produced in this manner.

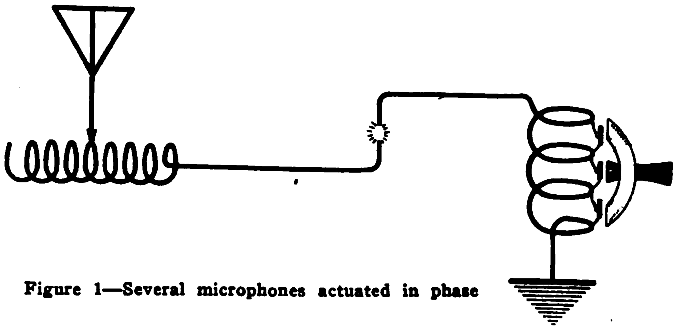


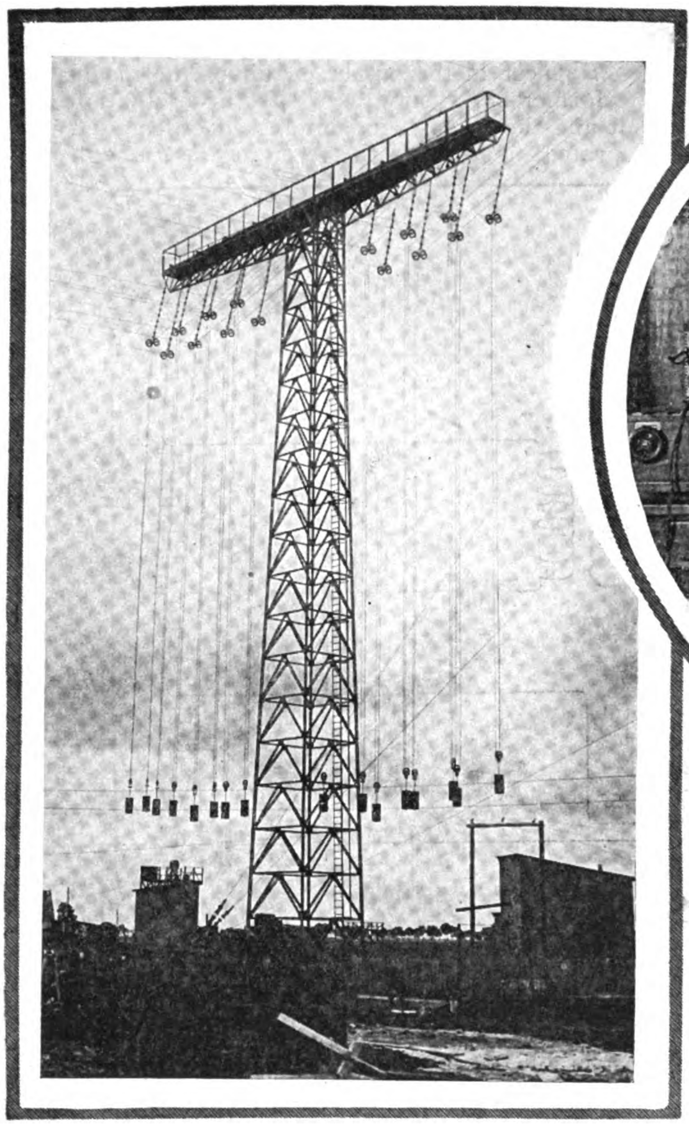
Figure 1—Several microphones actuated in phase

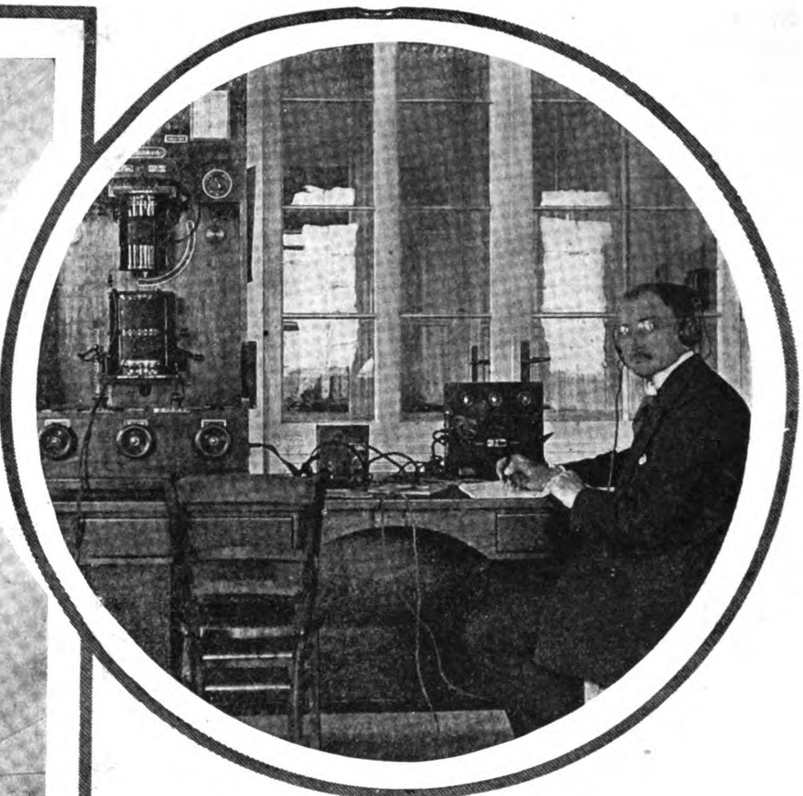
He has also devised means whereby several microphones may be actuated in phase electromagnetically.

The Radio Review

A HIGHLY technical publication, which appears under the title "The Radio Review," has recently been launched in London. Examination of the first issue makes it apparent that this carefully edited magazine will be of great assistance to radio engineers, for its mission is to report scientific progress in the art in a broad international way, and to shed special illumination on the radio conceptions and inventions of British scientists. This publication promises to occupy a niche corresponding to the enviable one attained in America by the "Proceedings of the Institute of Radio Engineers."

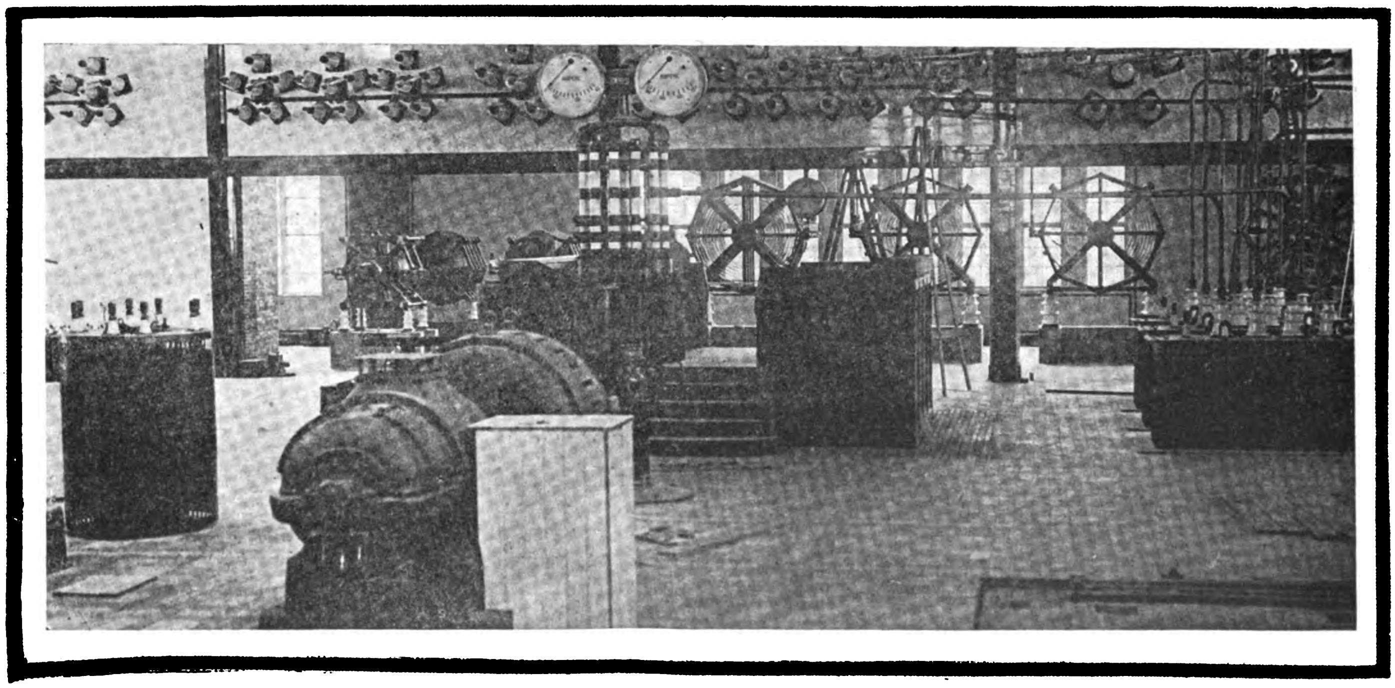
The keynote of the editorial policy, as sounded in the first issue, calls for a wide open forum wherein all science workers in the field of radiotelegraphy may communicate the results of their work and their opinions to their fellow workers. The scope of the articles will cover a broad range, comprising the treatment of subjects theoretical and practical, physical and mathematical, electrical and mechanical.





"Poz"—Nauen

Three views of the German station which acquired fame through the many historical messages sent from it during the war. At the left is seen one of the high towers which support the antenna; above, the receiving room, and below, the generating room, showing a motor generator, transformers and helices as part of the equipment that transmits signals overseas from a power source rated at 600 kilowatts



EXPERIMENTERS' WORLD

Views of readers on subjects and specific problems they would like to have discussed in this department will be appreciated by the Editor

A Medium Wave Regenerative Receiver

By Ernest G. Underwood

THE following is a description of a medium wave receiver — shown in the accompanying photographs — designed and constructed by myself for use on an antenna of about two hundred meters natural period. Using an antenna of this capacity, the range of the receiver is from two hundred meters up to and including thirty-five hundred meters without an external primary loading inductance. By insertion of additional inductance at the binding posts directly above the primary inductance switch, the effective range of the receiver may be increased to fifty-four hundred meters, which is the capacity of the secondary circuit.

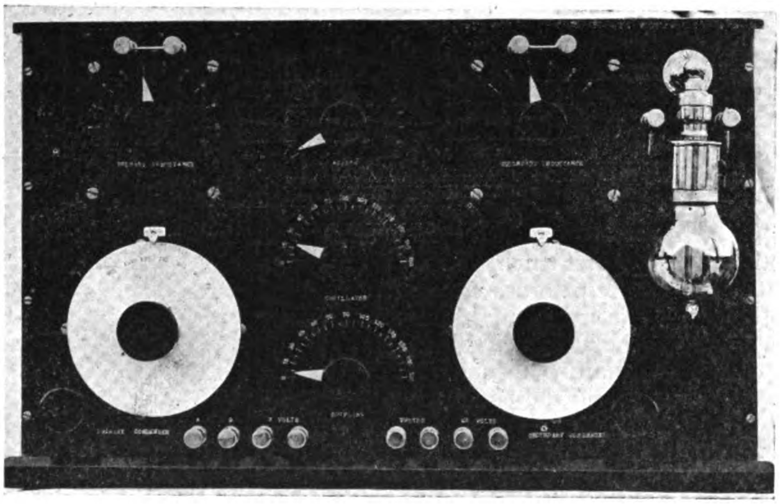


Figure 1—Front view of the medium wave regenerative receiver

This receiver is of the regenerative type, using the standard Navy regenerative hook-up, which has been found to be very efficient. Strong amplification of spark signals is obtained when the receiver is used for six hundred meter work. The receiver is also an excellent undamped wave receiver.

The cabinet containing the receiver is made of birch with a dark mahogany piano finish. The size of the cabinet is 11x19x10 in. The bakelite panel is 11x19x⅜ in., the front of which is finished in a dull gloss. All parts of the receiver are fastened directly to the back of the bakelite panel.

The antenna circuit consists of a movable primary coupling coil, primary loading coil, and a variable series condenser. The primary coupling coil is used for varying the coupling between the primary and secondary circuits and is wound with 37 turns of No. 22 D.S.C. wire on a tube 2 in. wide by 4¼ in. in diameter. The coupling is varied by rotating the knob marked "coupling." The loading coil is wound in two sections on a composition tube 6 in. long by 4¼ in. in diameter. The first section contains 168 turns of No. 22 D.S.C. wire and the second section contains 162 turns of the same size wire. Each section is bank wound in two layers. The loading coils are disconnected from the coupling coil when not in use by two dead-end switches operated by a small cam attached to the shaft of the primary inductance switch. The primary condenser is of the balanced plate type. The fixed and movable plate systems are in two sections arranged 180 degrees apart and are thus balanced. The maximum capacity of the condenser is .0013 mf. The condenser has a maximum capacity of .0013 mf. and a dial on the front of the panel made from a piece of aluminum and having a scale engraved on it is fastened to the shaft. A fixed pointer indicates the capacity being used. A knob mounted on the receiver panel at the left below the condenser knob permits the condenser to be adjusted very closely by means of gears connected to the movable plates. The taps for varying the primary inductance are mounted on the back of the panel and a scale engraved on the front of the panel indicates the tap being used.

The secondary circuit consists of the secondary coupling coil, loading coils, oscillator coil (tickler), secondary condenser, grid and bridging condensers and the audion control rheostat. The secondary coupling coil contains 56 turns of No. 22 D.S.C. wire bank wound in two layers on a tube 4¼ in. in diameter by 5 in. in length. Two sections of the secondary loading coil are also wound in the same tube and contain 74 and 87 turns of No. 22 D.S.C. wire respectively, bank wound in two layers. The loading coils are disconnected from the coupling coil by means of two dead-end switches. Taps for varying the secondary inductance are mounted on the back of the panel, the scale indicating the tap being used. The oscillator coil (tickler) is placed inside the secondary tube and consists of 90 turns of No. 22 D.S.C. wire wound on a composition ring 3½ in. in diameter. It is moved from a vertical to horizontal position by means of

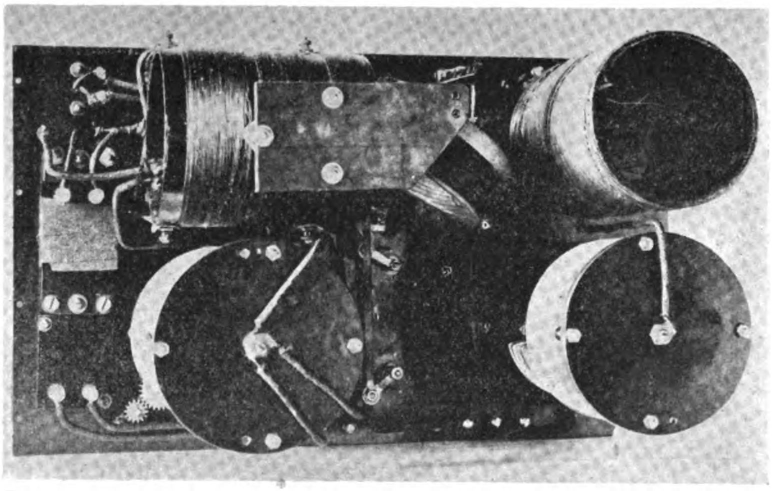


Figure 2—Back view showing secondary fine adjustment gears, and link motion for operating coupling coil

a lever motion which is worked by rotating the knob marked "Oscillator." The secondary condenser is the same size as the primary condenser with a maximum capacity of .0013 mf. and has a fine adjustment knob placed to the right and below the condenser knob. The grid condenser has a fixed capacity of approximately .00074 mf. The bridging condenser is variable by steps and has a maximum capacity of approximately .0025 mf. A standard 10-ohm battery rheostat, used for controlling the filament current, is mounted on the rear of the panel and is operated by the knob marked Audion. The socket for mounting the audion is at the extreme right of the panel.

Binding posts are provided for the connection of the antenna ground, filament battery, plate battery and phones.

This receiver has been in operation since July, 1919, and has given excellent results. The binding posts, audion socket and a small mica condenser, were the only complete parts purchased, all other parts, including the condensers, being home-made.

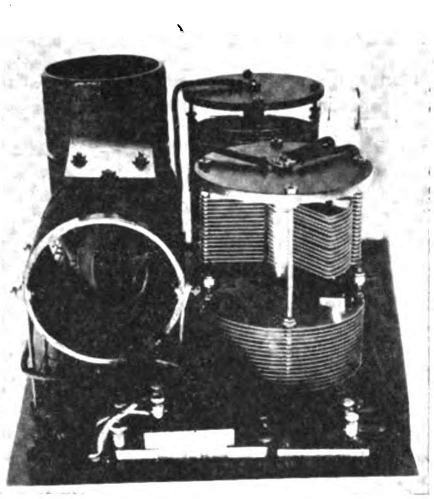


Figure 3—End view, showing method of mounting tickler coil

A Simple and Efficient Rotary Gap

By Wm. D. Reynolds, D.D.S.

THE gap here described has a marked quenching effect and is undoubtedly the easiest to construct of all rotaries I have ever made or seen.

A bakelite ring with ⅝-inch face, ¾ inch deep and 8 inches inside diameter and about 2 feet of ⅝-inch brass ribbon are the essential requirements.

Eight 2-inch pieces of the brass ribbon are first cut and bent in the manner shown in the accompanying diagram. After properly annealing, one inch of the brass ribbon is placed in a small vise. The protruding inch is grasped firmly with flat headed pliers and rotated a quarter turn, so that the ends are in planes at right angles to each other. A quarter inch slot is then cut in each piece of brass to permit adjustment and fastening to the bakelite ring. Eight holes are drilled and tapped equi-distantly around the face of the ring to hold the eight stationary electrodes.

The rotary electrodes are made of a single piece of the same kind of brass ribbon. One inch from each end the strip is twisted in opposite directions, making a fan-shaped rotating electrode. This is centered and bolted to a piece of bakelite and thus insulated from the motor shaft.

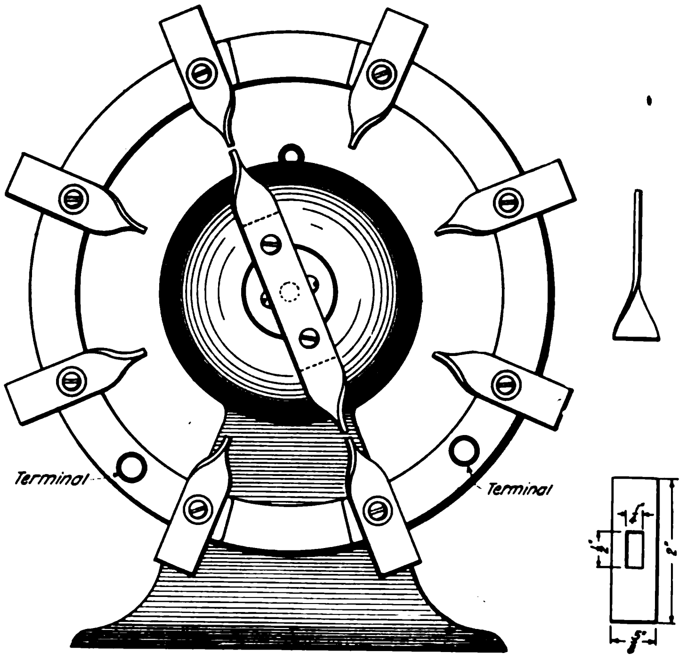


Figure 1—Assembled design of rotary gap and detail of stationary electrodes

The stationary electrodes should be so adjusted as to just clear the revolving member. The spark in this gap has practically no lead and does not jump until opposite the stationary electrodes. The peculiar shape of the revolving electrodes produces a blast of air which quickly quenches the spark and cools the gap.

This gap is easily constructed and correctly designed. The spark occurs between "knife edges" and is therefore almost instantaneous. The superiority of this gap over the slow starting heavy electrode gap is unquestionable.

An Economical "B" Battery

By E. L. Long

TO make an economical "B" battery secure one new dry cell which has a carbon element the cross section of which is a circle. Take off the outer covering of zinc in one piece. This may be easily done by making a cut lengthwise of the cell with a hacksaw. Remove the center carbon and with a hacksaw cut into pieces about ¼ inch thick. Now from the zinc cut out discs having a diameter equal to the carbon discs. These form the elements for the "B" battery cells which may be put together in the following manner. Bore a hole in a ½ inch piece of wood a trifle larger in diameter than the elements of the cells. Place this form on a smooth surface and put a carbon element flat in the bottom of the hole. Next place a thin layer of the black mixture from the cell in the hole, cover with a couple of discs of the blotting paper which should be remoistened. After having formed a small projection on the zinc disc with a center punch to serve to make the connection between cells more perfectly, place the zinc disc with the projection upward over the blotting paper and press the whole together tightly. Remove from the form and seal by using melted paraffin applied by means of a small brush or rag on the end of a stick. Twenty or more cells may be made in this way for the cost of a single dry cell, and they will serve very well as a "B" battery. They may be used by placing them in groups between springs fastened to a board or other support.

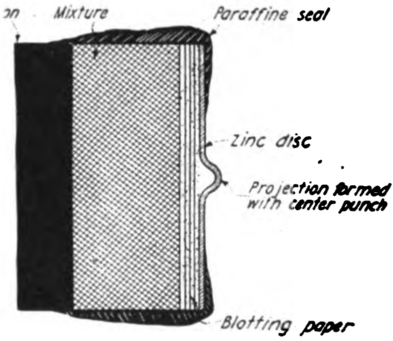
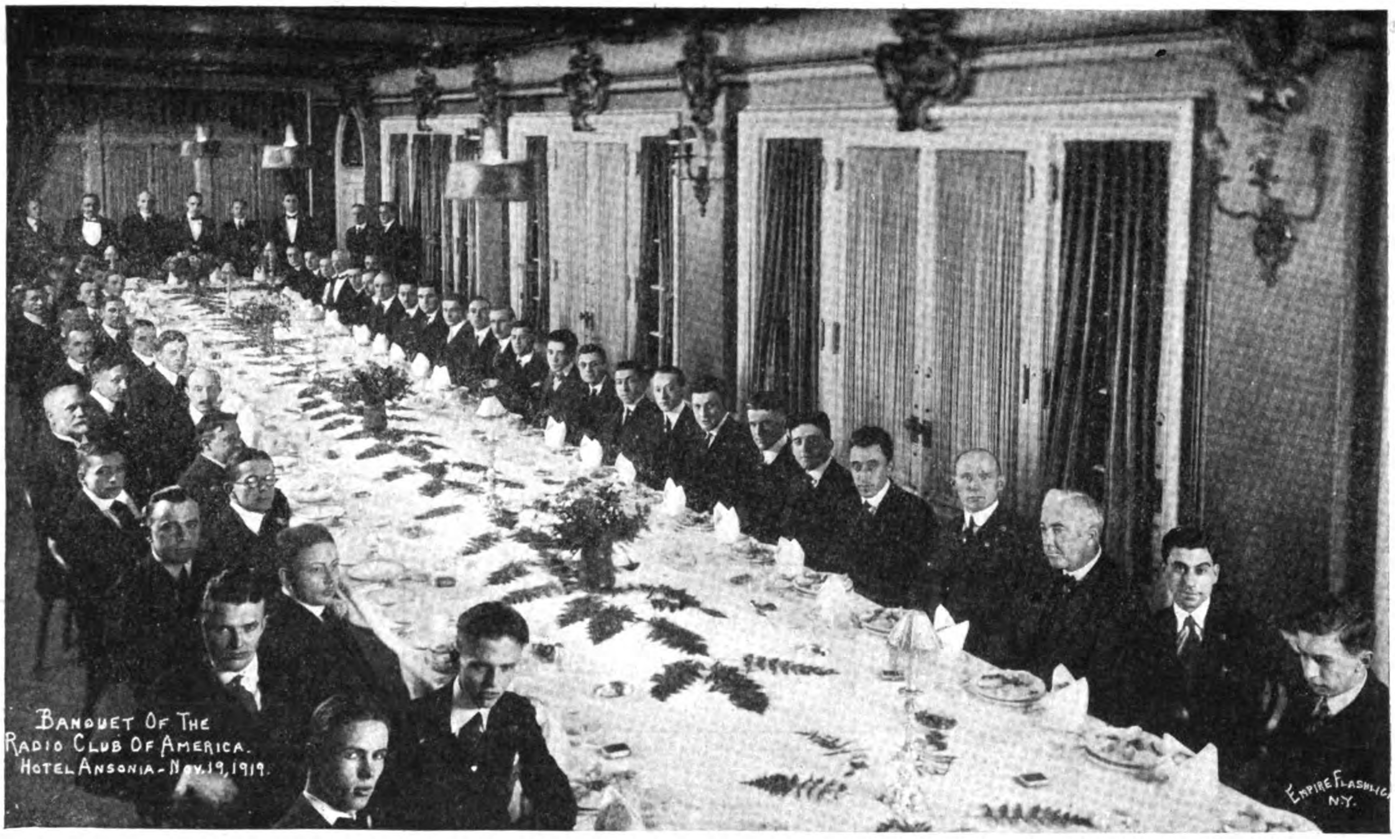


Figure 1—Showing constructional detail of the "B" battery



The three-score enthusiasts gathered to pay tribute to Major Armstrong. Those at the speakers' table in the rear, standing (from left to right), are: W. H. Davis, Prof. M. I. Pupin, Major Armstrong, T. Johnson, Jr., John V. L. Hogan, Dr. Alfred N. Goldsmith, George H. Clark and J. Andrew White

A Dinner to Armstrong

THE firm foundation in which amateur wireless rests in this country was clearly reflected in the testimonial banquet given in honor of Major Edwin H. Armstrong by the Radio Club of American on November 19, 1919. Sixty-four persons were present at the Hotel Ansonia, New York, to pay their respects to the returned president of the club, among whom were those who for ten years have held the leadership in directing the experiments in the New York district, and many men of distinguished scientific achievement who have inspired and encouraged the youthful workers in the art.

During the evening the guest of honor was acknowledged as the amateur who had set up new standards for the unpaid enthusiasts of wireless, established the work on a high plane and secured recognition for amateur radio. The debt to Armstrong, it was conceded, lay principally in the great merit of his invention of the regenerative circuit through which the sensitiveness of the vacuum tube receiver had been increased five thousand times. His work had been acknowledged by the conferring upon him of the medal of honor of the Institute of Radio Engineers, but it is a safe assumption that no tribute could have been more pleasing than the banquet given him by his original associates of amateur days. In the midst of this company it was recalled how he has remained an amateur at heart ever since the day seven years ago when, as a twenty-two year old college student, he perfected the invention which silenced the arguments of those that held amateurs to be meddlesome young men who accomplished no beneficial results in science.

T. Johnson, Jr., a director of the club and toastmaster for the evening, looked upon the club's activity in retrospect, fondly recalling its organization as a neighborhood proposition ten years ago and carrying its work through to the present day when it still retained its original usefulness and had the added prestige of accomplishment by many members. Prof. Michael I. Pupin responded with a sterling tribute to Armstrong's earnestness when a student at Columbia and gave many personal reminiscences of how the young inventor had challenged the admiration of men of great achievement, notably in the recent war, when French and British communication officers had been astonished at his feats in radio engineering.

Dr. Alfred N. Goldsmith responded with an appreciation of amateur workers as a whole, emphasizing the peculiar character of the hobby in that its converts always remained loyal — that they never recovered from the disease. He noted the significant fact that Armstrong had started with the most rudimentary apparatus, out of which he had erected a great structure of achievement and he looked hopefully to an immediate future holding great possibilities for other epochal inventions. The inspirational factor, he maintained, lay in the simple character of the apparatus itself, instancing the vacuum tube as virtually a three-element electric light; yet light at best could be thrown but a few miles, whereas radio signals spanned thousands and gave promise of circling the globe.

George H. Clark, former naval expert, told how at first the navy did not understand that the regenerative circuit was credited to Armstrong, stating that the principal reason for this was the modesty of the inventor. He gave an insider's view of the confidential inventions and developments made during the war and added a strong appreciation of the hard, conscientious and successful work of Major Armstrong as an officer abroad. Mr. Clark then, in lighter vein, effectively scored those of lesser accomplishment but greater pretensions, and with many witticisms drew a word picture of the results if all inventors were to adopt a like attitude.

Other speakers were John V. L. Hogan, Emil J. Simon, Capt. Willis H. Taylor, Jr., W. A. Davis and Prof.

(*Continued on page 36*)

First Prize—An Efficient Amateur Transmitting Condenser

By Norman A. Nyquist

THERE are so many different types of condensers being used for amateur radio work and so very little information available in regard to the types that are giving most satisfaction, that it is quite a problem for the average amateur to decide upon the proper type to build for his station.

A review of the various forms of transmitting condensers may be in order. Their advantages and disadvantages, in so far as amateurs are concerned, will be itemized accordingly:

No.	Type Dielectric	Advantages	Disadvantages
1	Compressed Air	Low losses Self healing Not fragile	Bulky Expensive Unreliable
2	Oil	Low losses Self healing	Bulky Sloppy
3	Glass & Oil	Fairly low losses	Bulky Fragile
4	Glass in wax	Fairly low losses	Bulky Fragile
5	Leyden Jar	Fairly low losses	Bulky Fragile
6	Mica	Low losses Very compact Not fragile	Initial expense

An analysis of the above data shows that for the ideal condenser, mica should be chosen for the dielectric. Mica is standard now in the Army and Navy.

In the average amateur transmitter arrangement of apparatus, the inductance of the leads are of such lengths that a capacity over .001 microfarads cannot be used on a wavelength of 200 meters.

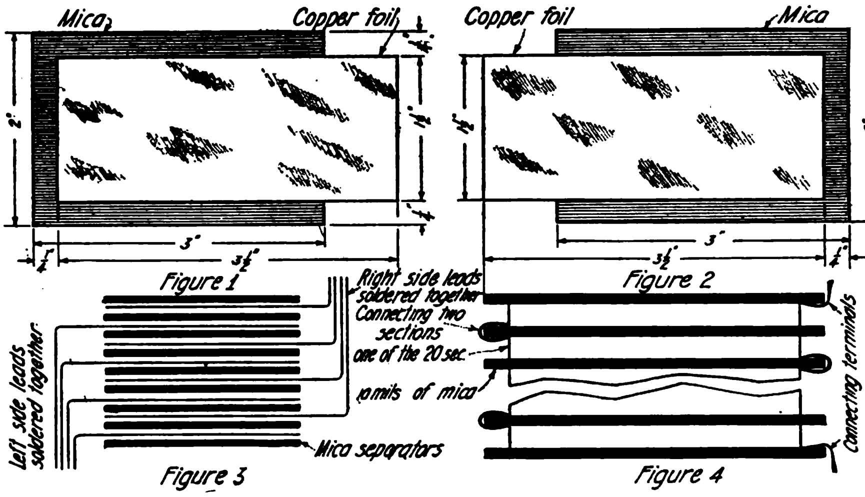
Condensers have electrical losses which summed up are referred to as the "power losses" of a condenser. A large portion of this power loss is in the dielectric between the metallic coatings. This loss is present in practically all insulators. This particular loss is due to "hysteresis" in the dielectric.

Experiments have been made to overcome the defects along this line, the results of which show that the energy absorbed per cycle in the condenser is proportional to the total energy in the condenser during the period, regardless of the frequency of the oscillations.

Therefore, that portion of the total decrement due to dielectric hysteresis is independent of the frequency of the oscillations or the physical size and capacity of the condenser and is wholly determined by the chemical composition of the dielectric and its temperature. There is also a small loss due to "eddy currents" in the metallic coatings.

During recent years much time and money has been spent by different radio investigators on research work with mica dielectric condensers and much valuable information has been obtained.

There is only one grade of mica which gives complete satisfaction, namely, Clear Ruby Mica, which is obtainable from the Mica Products Co., New York City. The cost of mica is rather high, but will not total the manufacturer's price on glass or moulded condensers.



Diagrams showing detailed plan of constructing the transmitting condenser

When purchasing the mica, sheets two inches by three inches should be specified, as this is a standard and convenient size. The thicknesses should be from two to three and one-half thousandths of an inch. The number of sheets required will depend upon the desired capacity of the condenser designed and the secondary potential which it will have to work on.

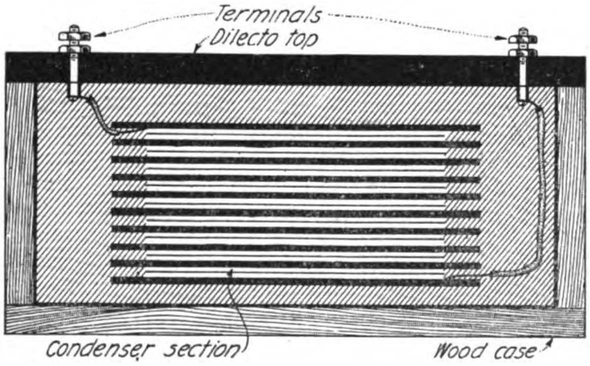


Figure 5—The finished condenser mounted in a case

Let us assume that a capacity of .001 microfarads is desired and that the secondary transformer voltage will be twelve thousand volts.

The particular grade of mica mentioned above will stand about 1,500 volts per one thousandth of an inch without puncturing, but the mica sheets should be tested before assembling. A convenient way of testing the mica is to use the transmitting transformer. A needle spark gap is set across the secondary terminals, separated one-tenth of an inch. Reactance is then inserted in the transformer primary circuit until the secondary voltage has been reduced to the point where it will only jump one-tenth of an inch, and no more, even if the gap is lengthened. Each piece of mica is now placed between two metal sheets slightly smaller than the mica sheets and connected across the secondary terminals of the transformer. All pieces of mica that puncture should be discarded.

Knowing that this mica will stand 1500 volts per mil, a safety factor of five is generally used, which means that each mil of mica is worked at one-fifth its tested voltage or 300 volts. As each mil is worked at 300 volts per mil and the mica is two to three and one-half mils thick, and a secondary voltage of twelve thousand is to be used, it figures out that we must have twenty sections in series.

If there are to be twenty sections in series and we want a resulting capacity of .001, the capacity of each section must be twenty times the desired capacity, or .020 microfarads.

The capacity may be calculated nearly enough by use of the following formula, and the proper number of plates per section can be determined roughly. The capacity need not be exact, as the capacity of the twenty sections in series is finally adjusted by taking off or adding a few plates to one of the end sections.

$$\text{Capacity} = \frac{2248\text{x}A\text{x}K}{d\text{x}10^{10}}$$

A = Total area of coatings
d = Dielectric thickness
K = Dielectric constant, 4 for the above grade.

The metallic coating for the mica should be dead soft annealed copper foil one-thousandth of an inch thick and one and one-half inches wide. It may be purchased in rolls of this size. About one-half pound will be required.

The copper foil is cut into pieces three and one-half inches long and assembled on the mica as shown in figures 1 and 2. About eight of these plates placed together will give a capacity of .020 microfarads. After the proper number of plates are assembled to give this capacity, the rest of the sections are made and the twenty sections assembled as shown in figure 3.

All the sections are now held in between two blocks of wood and clamped tightly in a steel clamp, such as is used by machinists, or in a hand vise. This whole arrangement is then placed in an oven and baked at a temperature of 250 degress F. for at least twelve hours, if possible the clamps should be tightened about every three hours.

During the last hour of baking, a compound consisting of one part beeswax and three parts rosin should be prepared, melted, and brought to a temperature of 250 degrees. After twelve hours of baking all moisture has been removed from the condenser. It is then placed in the boiling compound and left there one hour, the temperature being kept at 250 degrees F. during this time.

The unit is next taken out and left to cool. When cold the surplus compound is scraped off and the clamps removed.

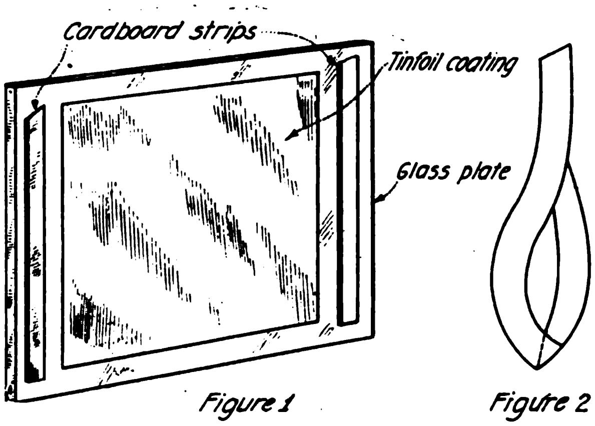
The finished condenser is mounted in a case as shown in figure 5, and the case is filled with the remaining liquid compound before it cools.

When soldering the copper lugs together as shown in the drawings, use the only soldering flux that will give complete satisfaction, which is equal parts of alcohol and rosin. The section should be tilted up-side-down when soldering so that the flux will not run into the mica.

The construction of this condenser entails considerable work and the various materials are quite expensive. It is, however, a real condenser,—worth all the time and effort required, and a unit of which any amateur may be proud. The substitution of a mica condenser for a glass and oil condenser will result in a 50 per cent. to 100 per cent. increase in radiation for a given input.

Second Prize—An Efficient Amateur Transmitting Condenser

By H. L. Stanley



Design of plates with separating strips attached and the connectors made of brass

THE amateur high tension condenser is usually the weak link in the chain of transmitting apparatus and the condenser described below was developed in an attempt to provide one that would be efficient, rugged, permanent, not too expensive, and capable of being built by an amateur himself with the assurance of success.

Glass plates were selected as being the simplest form of dielectric, having a suitable efficiency and for the ease of attaching the conducting medium. These plates were of plate glass 8x10 in. and varied from ¼ in. to 5/16 in. in thickness, and were obtained at a nominal price from a jobber in glass from pieces which would otherwise become scrap. Plates of this description have an average dielectric constant of 7.5 to 8 and are not affected by voltages up to 30,000.

Commercial tin foil 6x8 in. was selected for the conducting coating, as it was easy to obtain, cheap, and filled all the requirements better than any other coating obtainable. This foil was purchased in the form of a roll of the proper width to require cutting for one dimension only, and of a thickness which would be sufficient to carry the full capacity of the usual transformer without heating.

After trial of several mediums for attaching the foil to the plates, it was decided to use pure beeswax, as this material lends itself readily to the op-

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eration, has a very high dielectric value, does not form bubbles of gas under the foil and solidifies at once after being applied.

The glass plates were first washed in warm soapsuds and wiped with a cloth wet with alcohol to remove all grease, etc. The foil was then cut and the corners rounded off.

To apply the foil to the glass the plates were first heated to a temperature somewhat higher than necessary to melt the wax, and while they were hot the wax was applied in a thin coating all over the part of the plate to be covered with foil, the foil laid on in position, rubbed down with a soft rag on both sides of the plate and the whole thing run through the family clothes wringer.

If this operation is properly carried out while the plate is still hot the foil on both sides will be squeezed absolutely flat and into intimate contact with the glass, and the film of beeswax between the foil and the plates will be so thin as not to be noticeable.

The plates and the foil were then washed with a soft rag wet with gasoline and all traces of surplus was removed. After the plates were dry the foil was examined for possible pin holes and these were covered with shellac wherever found and a heavy coat of shellac was flowed around the edges of the foil. The shellac was used to prevent the oil in which the plates were to be immersed from coming into contact with the wax under the foil, thus dissolving it and allowing the foil to fall from the plates.

A rack was then built of dry wood to hold the plates in an upright position and an oil tight metal container built which would hold the assembly. This container was sufficiently deep to allow the plates to be covered when the case was filled to within one inch of the top with transil oil.

When the plates were assembled in the rack they were separated 1/16 in. by means of cardboard strips which were pasted across the ends of the plates with shellac. (See figure 1.) This separation is necessary for the connecting strips to be placed between the plates. The connecting strips were made of 1x.005 in. half hard brass of the shape shown in figure 2, and are long enough to meet over the center of the condenser when placed in position between the various plates. When the connecting strip in this form was pressed between the plates it made a good and sufficient contact with the foil on the opposed sides of two plates. The connectors were placed on opposite sides of each plate connected in one multiple unit.

A condenser constructed according to the foregoing manner has a capacity of approximately .01 mf. when thirty-five plates are included. This is the proper capacity required for use with the ordinary amateur transformer on a wavelength of 200 meters.

Condensers of this type have been in use for some time in several of the best amateur stations and they have given very satisfactory service, being characterized by the absence of the usual losses present in the amateur transmitting condenser.

Third Prize—Transmitting Oil Condenser Suitable for 200 Meter Amateur Sets

By George T. Droste

A TRANSMITTING oil condenser suitable for 200-meter sets and for powers up to 1 kw. is described.

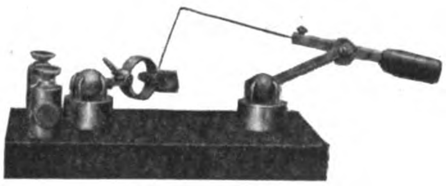
The material is easily obtainable and the condenser is easily constructed and highly efficient. I have been using one for over two and one-half years and there has never been a sign of a breakdown while under severe strain and using 1 kw. output. There is not the slightest sign of corona or brush discharge.

Following is given a list of material and sketches of the construction with all the essential parts being shown.

From a photographic supply house, obtain a composition Hypo fixing tank for 8x10 in. plates. This is a vertical black tank which looks like rubber. It is about 5¾ in. wide, 10¾ in. long and about 10 in. deep. The inside is scored or grooved at the sides for holding the plates vertically and raised baffle walls at the bottom are provided to keep the plates from touching the bottom of tank. The spacing of these grooves keep the plates about ⅝ in. from center to center and the tank holds eight 8x10 in. plates. (See figure 1).

Obtain eight 8x10 in. used photo plates. These may be had at the same photo supply house. Clean off the gelatin by soaking the plate in hot water and scrape off with a knife.

At a hardware supply house obtain sufficient copper foil to coat both sides of these eight plates with sheets 6x8 in. in size. Sixteen are required. This material comes about 12 in. wide, therefore, a piece 64 in. long is required, allowing enough extra for waste in cutting. This copper foil is recommended in preference to tin foil no matter how heavy the tin foil be,



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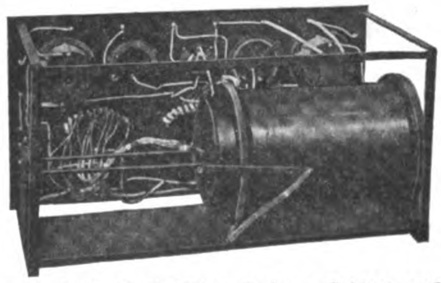

We reproduce the set in its entirety that you may see and understand its construction, instead of enclosing it in a Cabinet and allowing you to guess. It is now used in Schools of Radio instruction where Technical and satisfactory results are necessary.

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as it has tensile strength and does not tear in handling. No tabs for terminals are used. (See figures 1 and 5.)

Obtain from some hardware supply house enough stock for two pieces of brass 1/16 in. thick, ⅝ in. wide and long enough to fit the width of the tank. (See figure 2.) These pieces are bent down at the ends about ¾ in. and drilled and tapped for 12/24 screws for fastening to the tank and forming the terminals. On the long flat portion clear holes are drilled to take 12/24 machine screws. These holes may be slotted if the experimenter desires to allow easy removal of the clips. One piece is drilled with four holes and the other with five.

A dozen 12/24x1¾ in. brass round head machine screws and 24 hex nuts are obtained. Nine screws and eighteen nuts are used for the plate terminals, two screws and two nuts for condenser terminals. (See figures 3 and 5.) Next obtain enough spring brass ribbon 1/32 in. thick and ½ in. wide to form nine pieces as shown—see figure 3. This brass is bent as shown and soldered into the slots of the screw heads. The spring brass clips make rubbing contact with the foil plates at the upper edge and are all alike. Contact adjustment is easily accomplished by bending the lower part of the clip so that it will apply spring pressure between the foil plates or, by raising or lowering, which is accomplished by adjusting the lock nuts. (See figure 5.) 14/24 machine screws placed through holes drilled in the sides of the composition tank will support the horizontal bars. These holes in the tank must be near the top edge so as to be above the oil line, which has to cover the plates. The support bars are drilled and tapped in the turned down ends to take the screws. At one side these screws are long enough to take nuts for locking in position, and also form the binding posts of the condenser.

Two pieces of hardwood ½x⅝ in. and long enough to fit snugly between the walls of the tank are slotted with a hacksaw and the slot spaced the same as the plates. (See figure 4.) This separator is placed at both ends of the tank and holds the upper edges of the plates rigidly. (See figure 5.) The vertical grooves in the tank are tapered, being wider at the top.

The oil used is a standard transformer oil. Two gallons are needed. This will cost about 50 cents a gallon and may be purchased at any oil supply house. It is a vegetable oil and not a mineral oil and is poured into

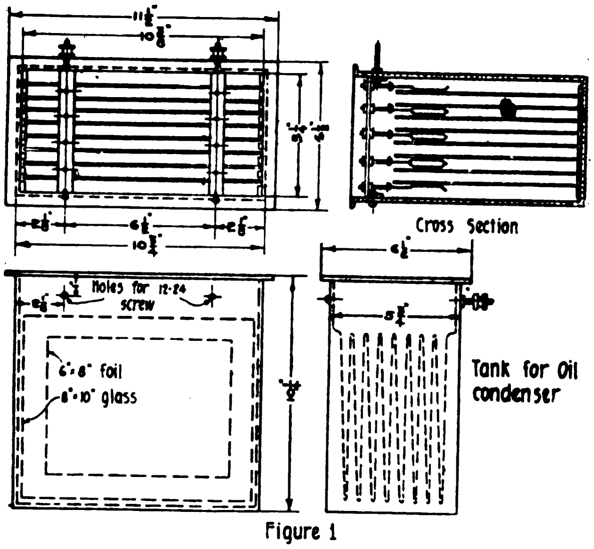

Figure 1

Detailed constructional plan and arrangement of plates of the oil condenser

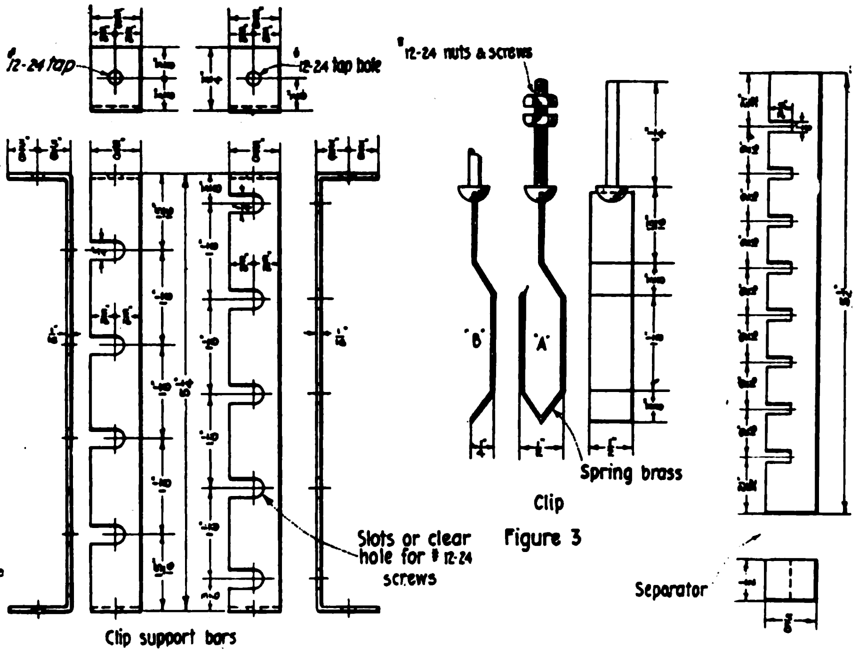

Figure 2

Figure 3

Figure 4

Constructional plans of the clip support bars, clips and separator

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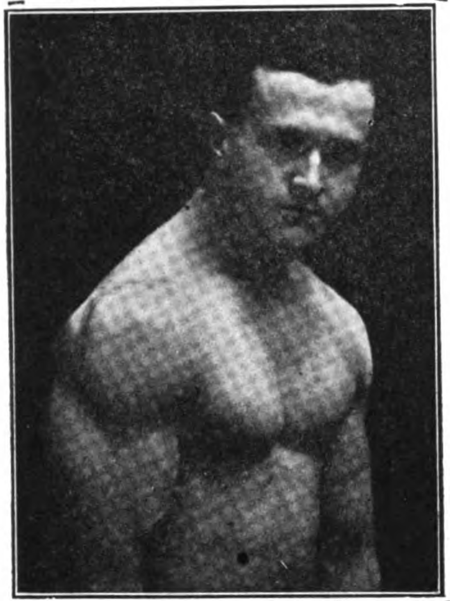

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the container after plates have been installed and connections made. The entire unit may be placed near. the transformer and oscillation transformer. A sheet of glass placed on top of the container will act as a cover. The foil is applied to the glass with orange shellac. Smooth it out with a squeege roller, or by hard pressure with a cloth pad. Do not use metal, as this will produce a curl to the foil, which makes it difficult to keep the edges down. After the foil is attached and the shellac dry, coat the entire surface of the foil and glass with shellac. Later clean the upper corner of the foil plate for the connections to the plates.

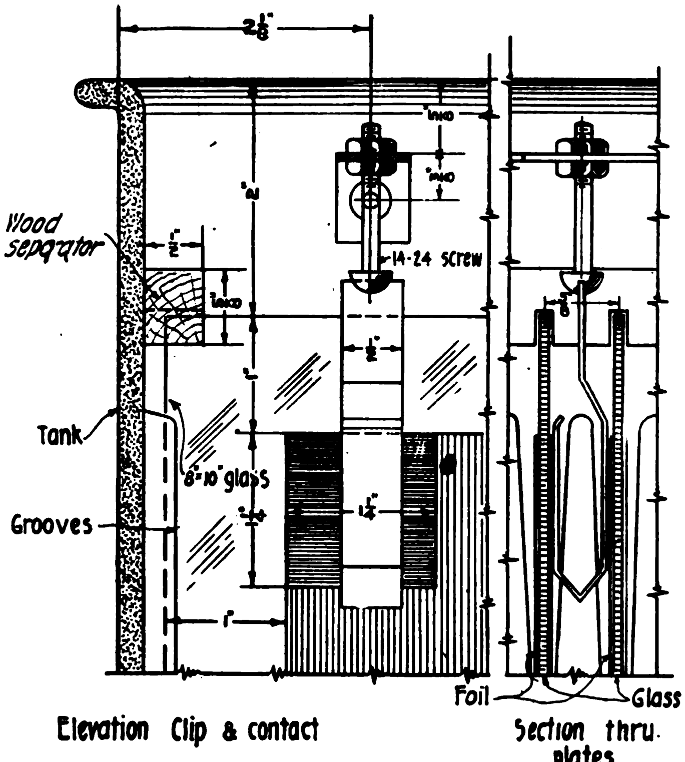

Figure. 5

Showing assembly of parts by means of a sectional and an elevation view

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National Amateur Wireless Association

Founded to promote the best interests of radio communication among wireless amateurs in America

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AMATEUR wireless suffered a distinct loss with the death of Horace A. J. Upham, prominent lawyer of Milwaukee and an active member of the N. A. W. A. Mr. Upham, who was 66 years of age, died of apoplexy while motoring near his summer home. He took a great interest in amateur affairs and was the leading spirit in the organization of the Milwaukee Club.

A. T. Hovey of Boston has announced the inauguration of a new method of doing business in the wireless field. He is arranging to receive orders for all standard makes of apparatus by radio and will have the station in operation so amateurs may communicate with him either direct or relay on Monday, Wednesday, Friday and Saturday evening from 7 to 9 P. M.

A Radio Club has been formed at New Mexico College which will have for its object the advancement of its members in technical, general and practical information concerning radio telegraphy. The club will have the use of the college radio house and a tower 140 feet high will be built, with an umbrella aerial.

Following is a list of the officers elected: Louis Eddleman, president; Mortimer Beaty, vice-president; Clarance Fite, secretary-treasurer; Professor Goddard, faculty adviser.

The newly formed Philadelphia Radio Amateur Association announces that its initial meeting proved very successful and the regular program will call for meetings to take place the second and fourth Monday nights each month at 1611 Columbia Avenue, Philadelphia.

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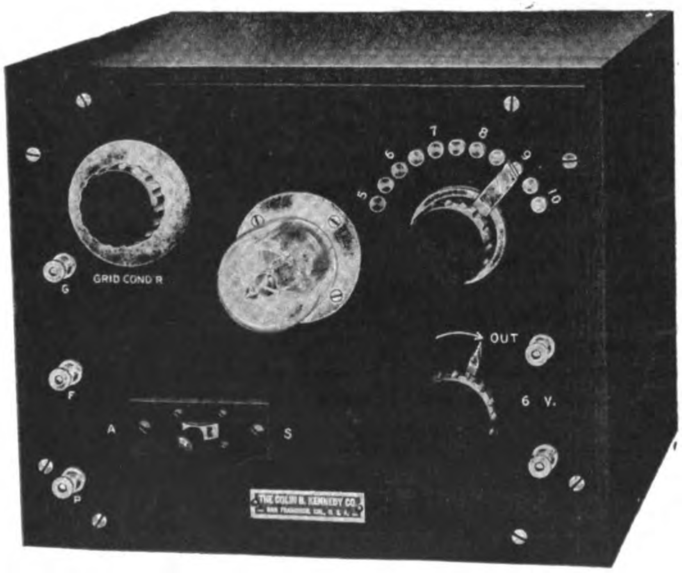

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In designing this apparatus we have endeavored to furnish the field with something more nearly approaching the type in Commercial use than, which, with a few exceptions, is at present obtainable at a price within the limits of the Amateur purse.

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Practically all of the parts entering into the construction of our apparatus are manufactured by us and by dealing directly with the amateur trade we are able to keep our prices within reasonable limits.

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The officers of the club are making arrangements to have demonstrations of apparatus and displays of meritorious equipment a regular feature of the meetings.

A prepared program is followed. Lectures and papers which have been thus far presented include: "Elements of Direct Current," by S. S. Harris; "Decrement," by Malcom Ferris; "Elements of Alternating Currents," by S. S. Harris; "Hook-ups for Honeycomb Coils," by P. J. Gallagher; "Poles and Aerials for the Amateur," by Elwood Casey.

At the initial meeting the following officers were elected: Gordon M. Christine, President; W. F. Wunder, Vice President; H. Paul Holz, Secretary and Treasurer.

The president is authorized to call an international communication conference to consider rates, cable and other questions, under a public bill passed by the Senate and sent to President Wilson. No date is fixed for the conference, which was conceived by representatives of the allies and the United States at the Paris Conference and is expected to deal with disposition of the German cables.

Bronze Victory buttons will be issued by the Navy Department to all persons who served in the reserve or regular Navy in the war. Recruiting stations have been authorized to issue them to all eligible persons now discharged or on inactive duty, and a supplementary distribution will be made from the Bureau of Navigation in Washington. Silver buttons of the same design, it was said, will be issued to those who received wounds during the war.

The Victory button, it was explained, is awarded in addition to the Victory medal, distribution of which is expected to begin shortly.

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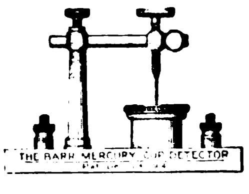
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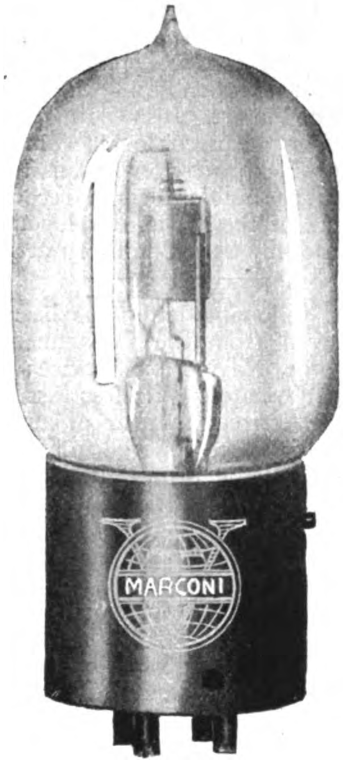

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It is a basic patent and controls broadly all vacuum tubes used as detectors, amplifiers or oscillions in radio work.

No one is authorized to make, sell, import or use such tubes for radio purposes, other than the owners of the patent and licensees thereunder. Any others making, selling, importing or using them alone or in combination with other devices, infringe upon the Fleming patent and are liable to a suit for injunction, damages and profits. And they will be prosecuted.

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The Navy Manual of Radio Telegraphy and Telephony has been completely rewritten, and, owing to the cessation of the war, much material formerly considered as essentially military secrets has been released.

As a result, the present edition may be considered as the most up-to-date and thorough treatise on radio-communication now on the market. It has the advantage of dealing only with apparatus and systems which have been actually used in service, and under the most severe conditions. Much of the apparatus which is here disclosed in the greatest detail has not hitherto been available in any publication.

Of especial interest are the chapters on the radio compass, radio telephony and aircraft radio apparatus. The latest static-reduction system, the underground antenna, and high-power systems are treated in detail throughout the work.

The book is well illustrated with photographs of apparatus in naval use, as well as with numerous diagrams.

All in all, the book has distinctive values because of its clear, comprehensive view of the radio art in general as well as for detailed and accurate descriptions of the newer phases of the art. It is especially well suited for the needs of the amateur, and for the professional man it supplies in accessible form a record of the state of the art as developed and stimulated by recent military activity.

THE following letter has been received from the Department of Commerce, Navigation Service:

National Amateur Wireless Assn.

Sirs: A great number of amateur radio stations are believed to be in operation without proper licenses, for the station and for the operator, having been obtained from the Radio Service, Bureau of Navigation, Department of Commerce.

When the war restrictions on amateur, training and instruction and experimental stations were removed by the Navy Department it is probable that many amateurs immediately be-

(*Continued on page 37*)

A Dinner to Amstrong

(*Continued from page 27*)

L. A. Hazeltine, all of whom were unreserved in their praise of the guest of the evening and the outlook for amateur wireless.

Major Armstrong characteristically refused to acknowledge himself an honored guest; he maintained rather that the occasion was merely a get-together dinner of club members and old associates. He expressed the wish that the tributes extended to him could be passed on to the great body of amateurs, saying, "the man that works the apparatus is, after all, the most important. In the war, the one greatest success was the amateur. Nothing ever shook my faith in his everlasting ability to keep up communication." He added that the great lesson of this experience was that amateur experimenting must be aided and encouraged in this country, and he hoped that the common sense of the nation would remain firm behind the view that the future should not bring forth any restrictive legislation. Radio frequency amplification on short wave lengths, now accomplished, opened up brilliant possibilities for amateur communication, he believed, and great days lay ahead.

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gan transmitting with their radio equipment under the impression that no additional authority was required.

I will greatly appreciate it if you will inform the amateur radio operators that transmitting radio stations of any kind or power come under the Act of August 13, 1912, and require a transmitting license from the above-named Bureau.

Many amateurs are also under the misapprehension that if they have a low power transmitting set which they believe cannot transmit beyond the limits of the State in which they are located, that they do not require a license. This is not the fact, inasmuch as the law includes stations which can interfere with messages from outside the State in which the station is located. This proviso, therefore, includes every transmitting station.

Licensed stations require licensed operators, and the amateurs' attention should also be called to this fact. There is a penalty of $500 provided for the person operating an unlicensed radio station, and an additional penalty of $100 and imprisonment of not more than two months or both for an unlicensed operator, and unless some of the offending amateurs are promptly advised of the necessity for station and operator's licenses there is a possibility of their being prosecuted for violating the law.

The necessary application forms and information regarding licenses can be obtained by communication with the U. S. Radio inspectors of the different radio districts. Respectfully, yours, L. R. KRUMM,
Chief Radio Inspector.

The Ham

WHILE looking over any up-to-date amateur station, if you should ever see among the pile of junk in the workshop traces of such things as a tomato-can variable, or a rolling-pin tuning coil, turn and shake the owner solemnly by the hand, for he is one of the few remaining specimens of the old-time ham—a species of radio experimenter that flourished to a great extent in the old days before the war. He is a pioneer, and should be accorded due respect. To him is due, to a great extent, the rapid progress made in radio, and now that he is gone forever the commercial "ops" who cussed him when he caused 99* will look back and forgive him.

The ham was sometimes a good operator, although most usually he was a nuisance. His wave was always open to criticism, and his decrement was expressed in hundreds. His tone was the sure criterion of his class—if a true ham, it was indescribable, but will be happily remembered as something never to be heard again. Usually it was low, born of the union of a Ford coil and an electrolytic interrupter, but occasionally it would be high and musical—for a few minutes. This showed the ham had a real spark coil, was running it from batteries hooked from a friendly garage, and that the vibrator needed adjustment. Sometimes he used a condenser, a wonderful thing made of tobacco tinfoil and odd pieces of picture glass that the family wouldn't miss. If he owned a helix, it was constructed of wood and 18 telephone wire. An "O T" was unknown and

---

*Old signal for QRM.

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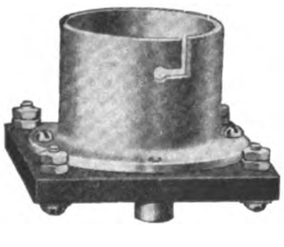

The Ace Vacuum Tube Socket is designed to fit the Standard four prong vacuum tube. The top part consists of a finished aluminum casting, mounted on a formica base ½ inch thick. This base will not break under any condition of service, as moulded composition bases will. Heavy phosphor bronze springs are mounted on the under side of the base for connection to the tube prongs.

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wild man who talked of making one was promptly dubbed as crazy. His aerial switch, if he used one, was once the switch of an auto coil, with slight changes. Since the "set," as it was always reverently termed, was usually in the shed (the family wouldn't let the thing in the house) a lightning switch was unknown and unnecessary.

For receiving purposes he always began with an 80 ohm phone and a single slide tuning coil wound with bare wire on a rolling pin, with string to space the wire. For detector, silicon was the favorite, though occasionally one would find perikon, perikon-electra, pyron, electrolytic, or galena. Soon he would graduate and build himself a loose-coupler, and buy a single 1000-ohm phone, in which case he was of the elite, and had the "best set in town."

But it was by the aerial that the true ham was really known. It invariably had one pole (of bent eucalyptus) in the backyard for one spreader, with the other attached in some weird manner to the house. It was insulated with everything, from old pop bottles to porcelain cleats salvaged from somewhere, and its wires were anything from the 18 telephone already mentioned to 14 galvanized iron. The spreaders were always at least 16 feet long—sometimes longer, for the ham had been told he could receive farther that way—and held from two to four wires. On such an aerial a true ham could copy NAA during the daytime half way across the continent, and with his Ford coil transmitter would work fifty miles through the worst 99 imaginable. I don't know why a true ham could always work farther than a mere commercial operator, but I suppose it is because he is a ham—for no one else could do it.

The ham's code was never to buy anything under any circumstances. This may have been why his publicly expressed opinion was always against such "trappings" as an Audion. "Such things ain't for us. Look at all the junk you gotta have. A bunch o' batteries, rheostats, and the darn things don't work half the time anyhow. No siree—no such junk in *my* station," he would remark when it was mentioned. Probably if an Audion could be made by him in his own workshop he would have had a seven-step amplifier, if he knew that such a thing existed, but he would absolutely refuse to allow any instrument with the taint of commercialism upon it to enter his station.

I have endeavored to set down the chief characteristics of the famous ham as he was in days gone by, and I have tried to do this in a friendly spirit, for I was a ham myself, and used to jam the ether at four words per by the hour, using about 2 k. w. talking to a fellow in the next block, perfectly oblivious to the BK's from nearby commercial stations. About 90 per cent of the 2 K.W. was used up in heating the interrupter. It was a wonderful life, but the day of the ham is past, and specimens now are few and far between. The place of the ham has been taken by a young, smart Alec who prates wisely of heterodynes, logarithmic decrement, vacuum tube transmitters, the relative efficiency of tuning by capacity and tuning by inductance, and other such things unknown to the simple ham of yesterday. We do not mean to unduly rebuke the present generation of radioists, but the ham was dear to our hearts, and we hated to see him go.

The King is dead—long live the King!

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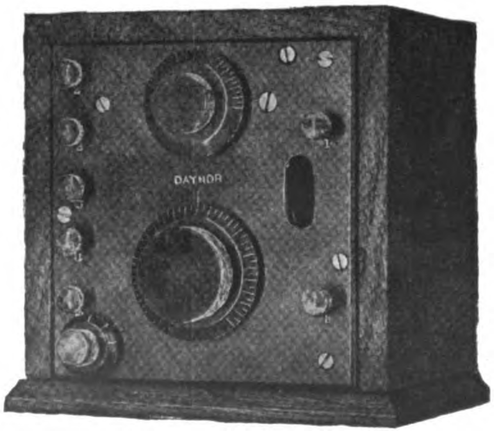

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Suggestion for Prize Contest—February Wireless Age

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Queries Answered

Answers will be given in this department to questions of subscribers, covering the full range of wireless subjects, but only those which relate to the technical phases of the art and which are of general interest to readers will be published here. The subscriber's name and address must be given in all letters and only one side of the paper written on; where diagrams are necessary they must be on a separate sheet and drawn with India ink. Not more than five questions of one reader can be answered in the same issue. To receive attention these rules must be rigidly observed.

Positively no questions answered by mail.

G. L. L., St. Anthony, Iowa:

In connection with your query concerning the four-stage amplifier described on page 33 of the April WIRELESS AGE, we suggest that before you spend any money in making up an amplifier incorporating this circuit, you set up one of the circuits to familiarize yourself with its action. Having done this, it will also be possible for you to make comparisons and draw your own conclusions. We regret that we are not in a position to do this for you.

* * *

R. C. A., Long Beach, Calif.:

With reference to the four-stage amplifier described on page 33 of the April issue, your inability to get oscillations on the three stages is due to the fact that the phase displacement or the "timing" of the third valve with reference to the first valve is not as it should be. It will be necessary for you to add a fourth tube, and if it should be desired to add more, it will be necessary to add them in pairs. Any tubes which have approximately the same characteristics are suitable for the hook-up above mentioned, that is, the tubes you select for this work should all operate on the same plate potential and approximately the same filament current. The amount of energy passed in the plate circuit of these tubes is very small and the resistances are sufficiently low to supply the required energy to the plate. It will be possible for you to use a three-stage radio frequency amplifier, but if you do so, it will be necessary for you to supply the oscillations to heterodyne incoming signals in some other way than that described. It might be done, for example, by the use of a fourth tube as an external oscillator.

No matter how many tubes are used, providing they have all been selected with regard to similarity of characteristics, the plate battery required will be the same. In connecting up three-element tubes, it is the custom to join the negative side of the high potential battery to the positive side of the filament battery as has been indicated in the diagram on page 33, April WIRELESS AGE.

The idea in supplying a local grid battery is to enable one to charge the grid negatively, in which case the negative terminal of the battery, of course, would be connected to the grid and the positive terminal to the filament.

We regret that we are unable to give you any comparisons which would be of more value to you than the comparisons between the various circuits which you are able to make for yourself. Using four tubes instead of three with the circuit, however, should increase your range considerably.

The Rogers underground antenna has no merits which would appeal to the amateur in particular. As we understand it, it has

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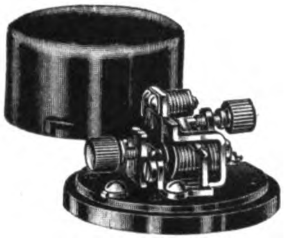

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been originated in the belief that it aids materially at times in securing a better signal to static ratio. The energy picked up by such an arrangement, however, is very small in comparison to the energy picked up by an overhead antenna, and generally speaking, is not apt to become popular with the experimenter.

* * *

W. R. R., Pelham, N. Y.:

With reference to the fourth prize article in the July, 1917, issue we regret that we are unable to tell you where to get gem salts or Peeble's powder. It may be that Mr. McIlvaine will see this query and supply you with the information. We are unable to find his present address. We presume that white wood or bass wood would take the finish described fully as well as, if not better than, cypress.

* * *

A. R., Scottville, Mich.:

Approximate fundamental wavelength of an antenna may be obtained by multiplying the length of the antenna plus lead-in, plus ground connection, in feet, by 4, which will give the wavelength in feet. For reduction to meters, the result should be divided by 3.3.

The fundamental wavelength of a four-wire aerial spaced 32 inches, which is 80 ft. in length and having a 30 ft. lead-in and a 15 ft. ground, is approximately 150 meters.

* * *

A. T. S., Betheny, Nebr.:

The condensers C-4 shown in the circuit on page 33 of the April Wireless Age have a value of .005 mf. each. The ordinary stopping condenser, as sold for use in crystal detector circuits, will serve the purpose admirably, or you may make one by cutting two strips of tin foil 2 inches in width and about 14 inches in length, the two to be separated by paraffin paper 2½ mils in thickness, and wound up until the whole forms a unit about 2½ inches in length by 1¼ inches in width.

With reference to the multi-layered receiving transformer described on page 34 of the September issue, this type of transformer will probably prove more efficient on the longer wavelengths than the usual single-layered solenoid.

* * *

A. C. C., Oneida, N. Y.:

The Armstrong receiving set described on page 39 of the February Wireless Age, was designed for 200 to 600-meter work. The 50 turns of wire need not necessarily have a tap taken off every turn, but if it is desired to do this, it may be accomplished by making a loop of wire long enough to reach the switch for every turn and tying the loop together tightly at the point where it leaves the coil with thread. After the coil has been wound, under these circumstances, it should be carefuly varnished.

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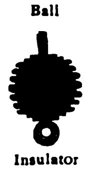

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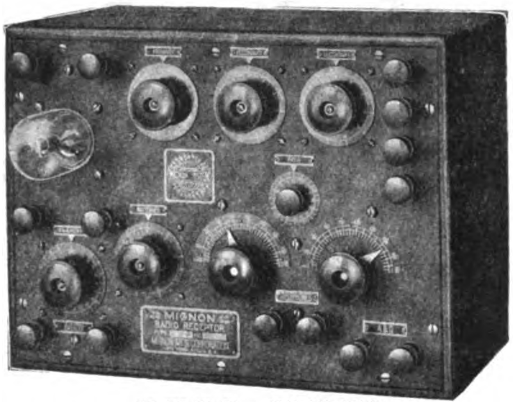

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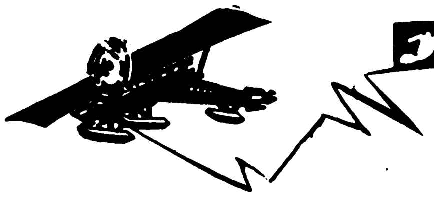

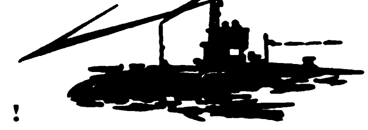

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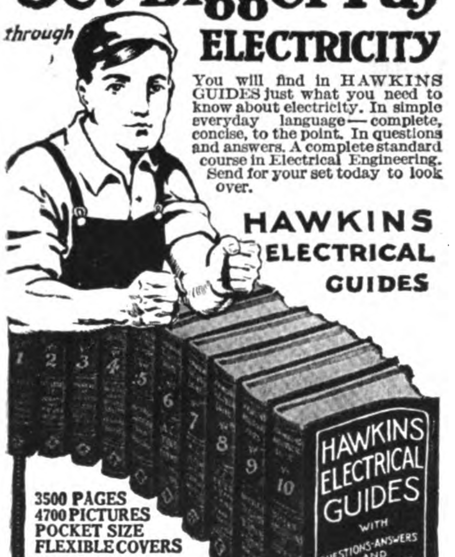
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Reference__________ W. A.

ence whether you used a 100 ft. aerial or an 80 ft. aerial in connection with a short wave receiver. It would only be necessary in the case of the longer one to compensate for its additional length by the use of a smaller value of series tuning condenser.

With reference to the article on page 41 of the April issue, it will be all right for you to substitute single silk covered wire for the double silk covered wire called for.

This also applies to your question concerning the article in the May issue. You would probably get best results by using either of the receivers described in the February and May issues.

* * *

H. W. S., Binghamton, N. Y.:

We see no reason why you are unable to get results with the cabinet set when working with your antenna. It would be better if you used solid copper wire instead of copper clad, but this should not entirely prevent your getting some results. Look for loose connections, or it may be that the dimensions of the aerial on which the set was tested are entirely different from the dimensions of your own aerial which might, depending upon the set itself, make considerable difference. The wavelength of your aerial is approximately 170 meters. The manufacturers of the receiver should be willing to help you out.

* * *

A. B., Hartford, Conn.:

We have noted your diagram and find nothing wrong with it providing you leave out your 15,000 meter loading coil. It will not be possible for you to tune to 15,000 meters by the use of a loading coil in conjunction with the loose coupler which you describe. In order to reach this wavelength and to receive undamped waves, you should provide yourself with coils similar to those described in recent issues of the WIRELESS AGE, and a Marconi vacuum tube.

"Practical Wireless Telegraphy" by E. E. Bucher, will thoroughly explain damped and undamped waves, and tuning. This will be supplied to you upon application to the Wireless Press, Inc., 64 Broad Street, New York City.

With the outfit which you now have, you should be able to receive upwards of 100 miles. We cannot tell you exactly because you have told us nothing concerning the dimensions of your aerial.

* * *

R. D. W., Plainfield, N. J.:

With reference to your query on page 44 of the July WIRELESS AGE, Mr. Allen C. Rockwood, of the Iowa State University, advises that radiosite consists of specially selected crystals of iron pyrites. We are also informed that lenzite is generally known as iron faced galena.

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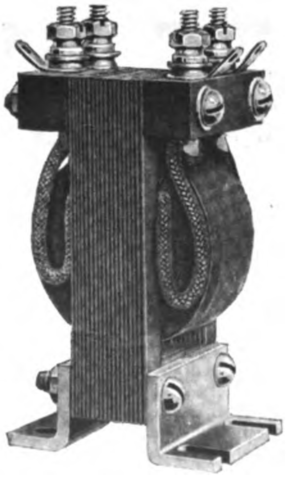
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Vacuum Tubes In Wireless Communication	"	1.75	2.25
Practical Aviation	Major J. Ahdrew White	1.75	2.25
Signal Corps Manual	"	1.75	2.25
Radio Telephony	Dr. A. N. Goldsmith	2.00	2.50
Radio Instruments and Measurements		1.25	1.75
Elementary Principles of Wireless Telegraphy. In Two Parts	R. D. Bangay	2.25	3.25
How to Pass U. S. Government Wireless License Examination	E. E. Bucher	.50	.75
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C. H. McS., Pittsburgh, Pa.:

The honeycomb coils seem to be very popular with amateurs generally. They can be purchased separately, we believe, and refer you to the advertisements.

The only vacuum tube on the market is the Marconi vacuum tube. Vacuum tubes of the types used by the Navy and Army cannot be purchased.

No special hook-up is required for the reception of wireless telephone speech, and vernier condensers are not necessary in order to tune in radio telephone signals.

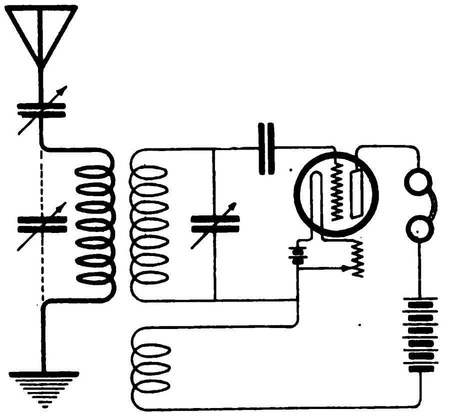
In reply to your fourth question, we again refer you to the advertisements.

* * *

R. R., Wapinitia, Ore.:

In addition to the vacuum tube and the honeycomb coils you will need two variable condensers, having a capacity each of approximately .001 mfd. A storage battery for lighting the vacuum tube, a battery of dry cells giving you about 30 volts for feeding the plate circuit, a ten ohm rheostat for adjusting the filament temperature, and a pair of telephones.

A diagram of connections is shown below:



H. H., Atlantic City, N. J.:

Most spark coils give a scratchy note because of the fact that the vibrator either is not or cannot be properly adjusted. Best results are obtained from a spark coil when the note emitted is smooth and musical. The pitch of it does not matter so much, but usually best results are had with medium low pitch. This can only be obtained by experiment.

The single wire aerial, 300 ft. long and 40 ft. in height, may be used for transmitting with a 1½ in. spark coil. It is, however, too large for best results, and in addition to this, the wavelength would be in the neighborhood of 500 meters. The natural wavelength of the aerial is about 450 meters.

* * *

E. H. K., Detroit, Mich.:

Arlington sends out time signals at 9 P. M. Detroit time.

The natural wavelength of a four-wire antenna, 55 ft. long, and 35 ft. in height, with a 7 ft. lead-in, would be approximately 135 meters.

* * *

R. Y., Toronto, Ont.:

The hook-up which you have forwarded us is not a particularly good one for your purpose. In case you wish to use it, the bridging condenser around the telephones is not absolutely essential, although the range over which oscillations are available with your hook-up should be materially increased by its use.

The tickler coil design which you ask about is not suitable for long wave work. For data on the construction of long wave receivers we suggest that you read carefully the prize articles printed in the September Wireless Age.

The grid leak may be connected in shunt to the grid condenser, provided the lower terminal of the secondary of the coupler is connected to the negative terminal of the lighting battery, or it may be connected direct from the grid to the negative terminal of the lighting battery.

If your vacuum tube functions properly, the fact that the plate is a little out of line will not in any way affect your results.

* * *

W. G., Burlington, Iowa:

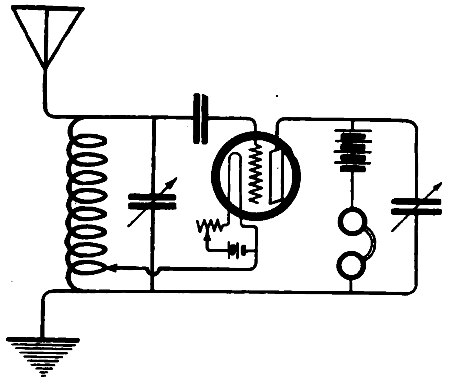
We regret that we are unable to give you the address of anyone who makes the double filament auto headlight bulbs. Such a bulb could, no doubt, be used for the rectification of alternating current at voltages depending upon the insulation between the two filaments, but we are inclined to believe that electrodes so small as these would necessarily be, would not work at all efficiently. An electrolytic rectifier would in all probability give trouble at 400 volts, particularly if an effort were made to draw any considerable amount of current through it. We regret that we have had no experience with electrolytic rectifiers at voltages higher than 100.

* * *

C. R. U., Rutherford, N. J.:

The diagram which you show would not be an efficient receiver for undamped long wave stations. If you desire to use a single coil, connect your apparatus as per diagram herewith.

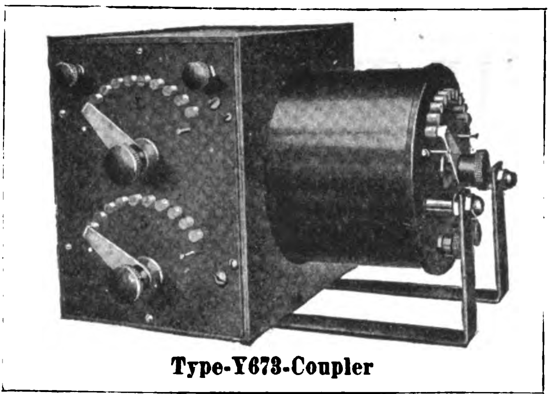
The vacuum tube which you mention as being 3" in diameter and having plates ¾" by about 1 5-16" could be used as a rectifier on 60 cycles, 110 volts, connected as per hook-up shown below.



A. R., Scottville, Mich.:

Question 1—The charges on all radiograms are collected at the office of origin, in U. S. currency. The charges will depend upon who controls the radio station on the ship that relays the message. As an illustration: On a ship equipped with Marconi apparatus and controlled by the Marconi Company, the ship tax will be four cents a word; relayed through a ship not equipped and controlled by the Marconi Company, there is a relay charge equal to the ship tax of the relaying ship, generally four cents a word. There is then the coast tax at the New York station controlled by the U. S. Navy, six cents a word. To this must be added a Western Union forwarding charge from the Naval station in New York to the point of destination. Should the relaying ship be controlled by the same company as the office of origin, there would be no charge for relaying the message.

Question 2—A message is seldom relayed through a number of ships as the operator at the office of origin must route his message to shore before sending, in order to be able to compute the charges. If a message must be relayed and it cannot be done in one relay, the message is usually not accepted from the public until the ship can establish better communication. In this case, question one answers number two.



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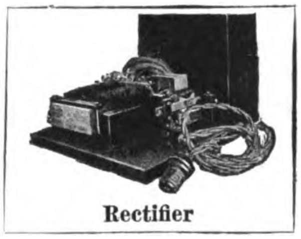

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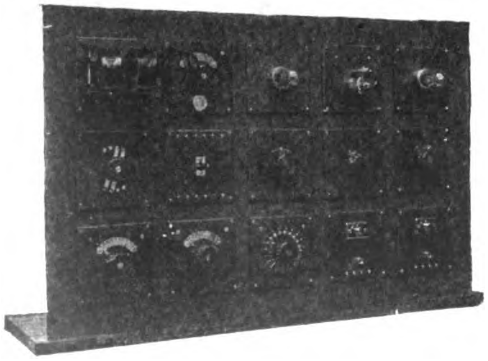

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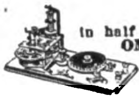

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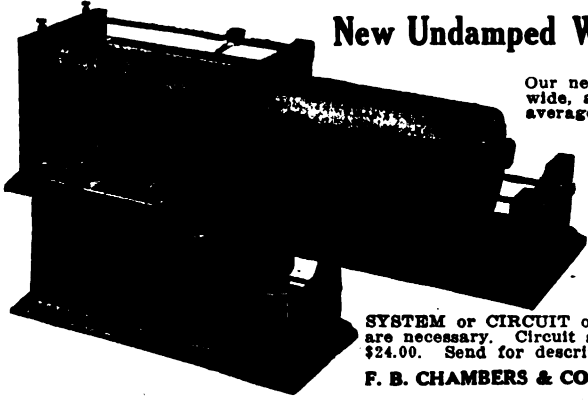

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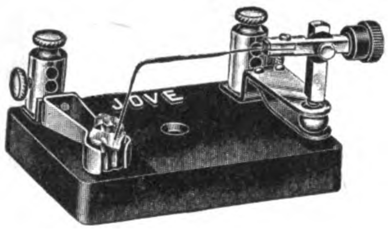

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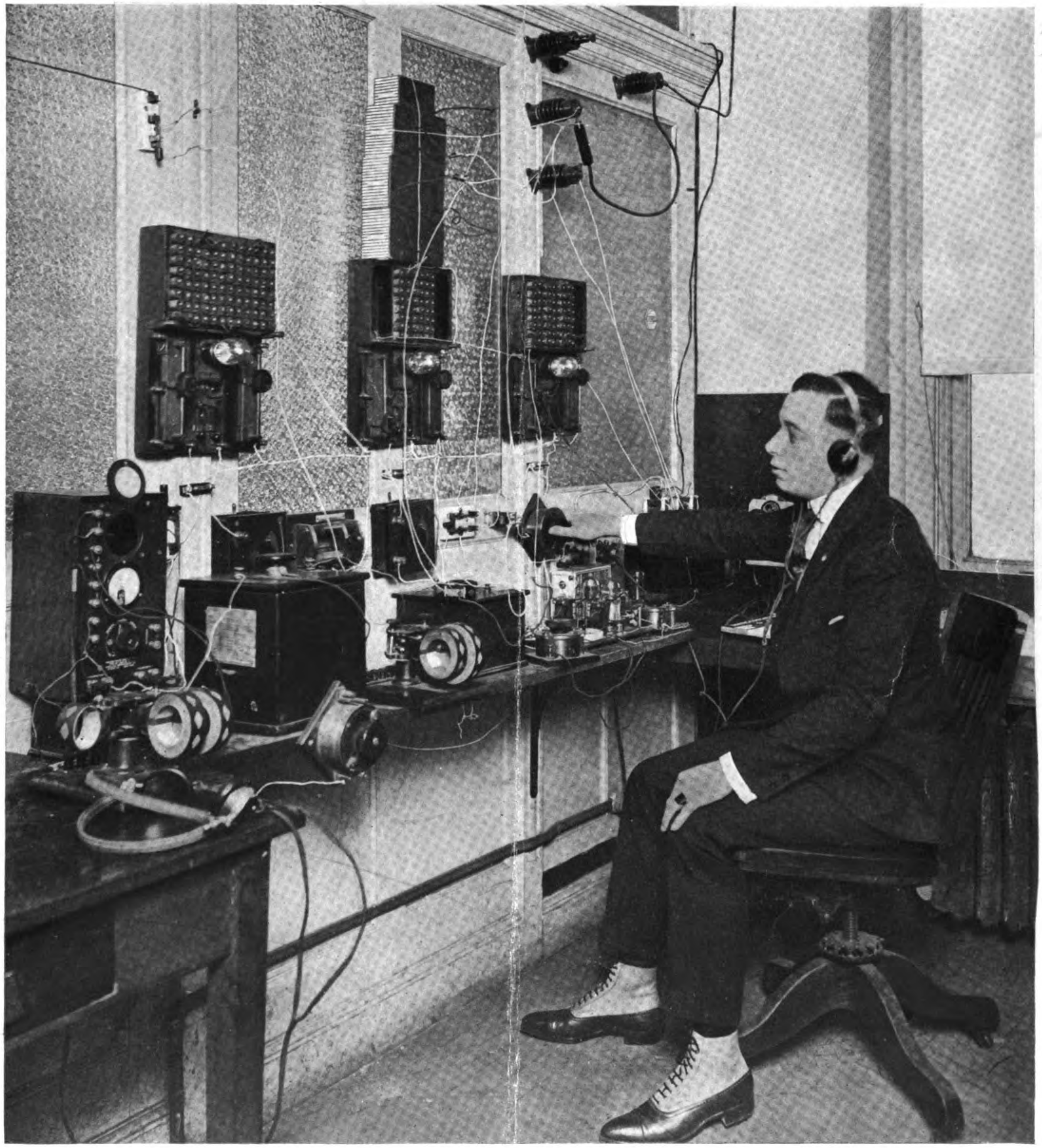
The WIRELESS AGE

Volume 7 Number 4



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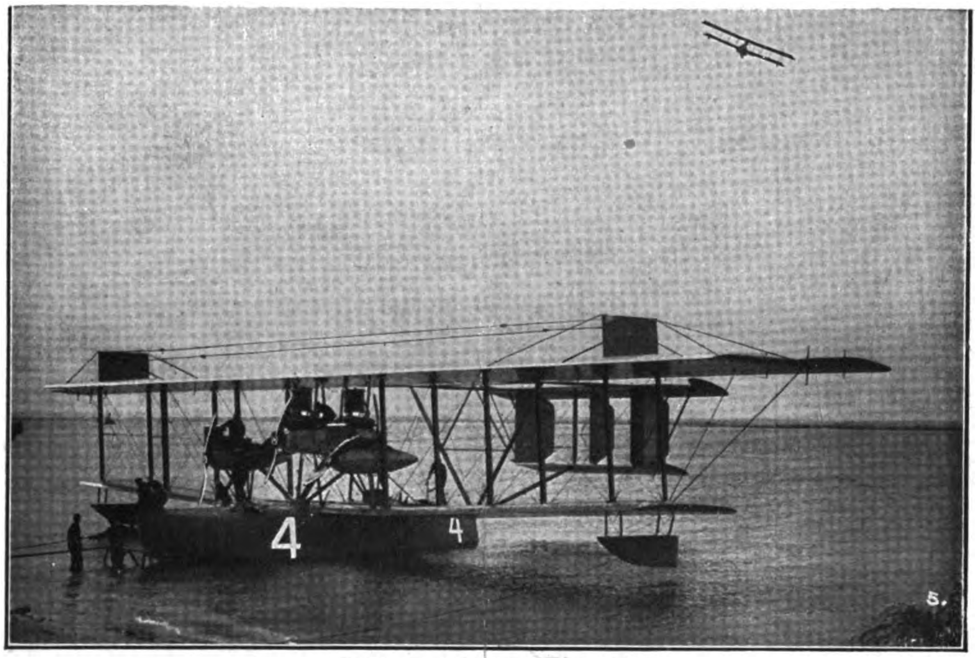

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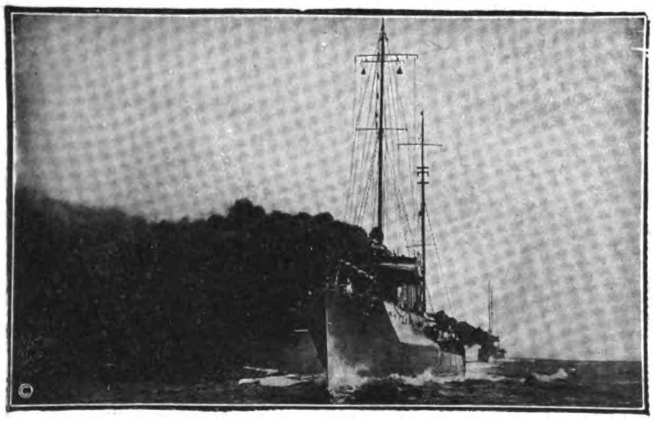

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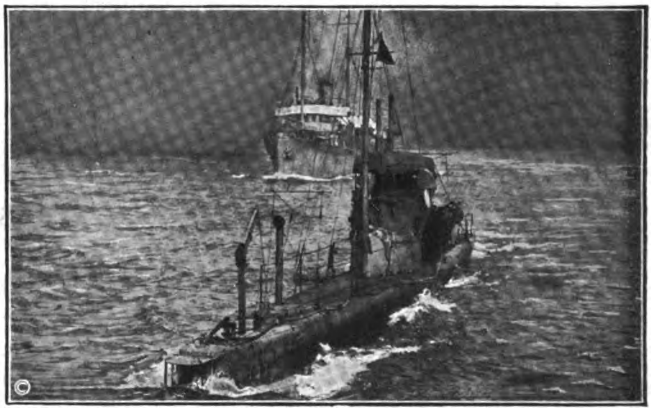

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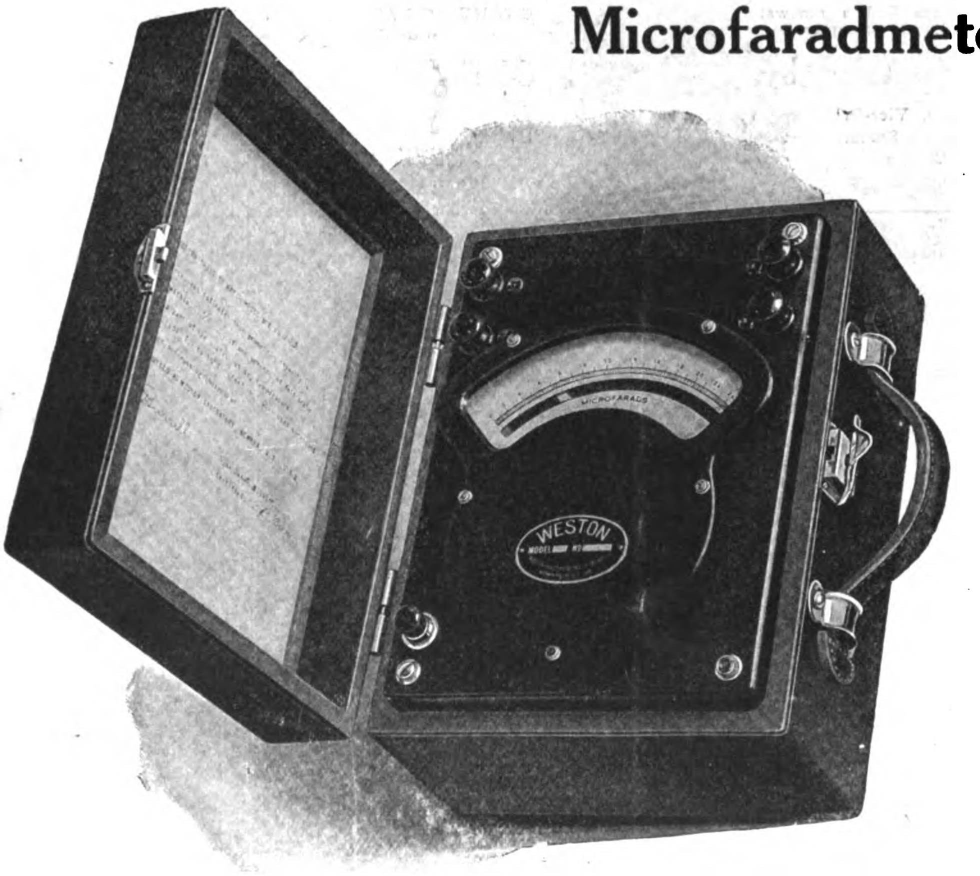

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The Wireless Age

Edited by J. ANDREW WHITE

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Vol. 7 No. 4

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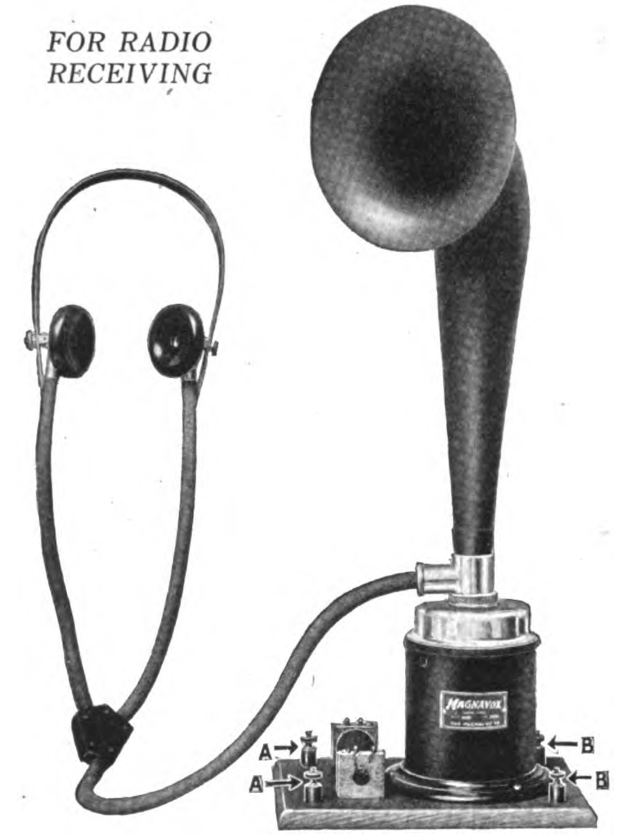

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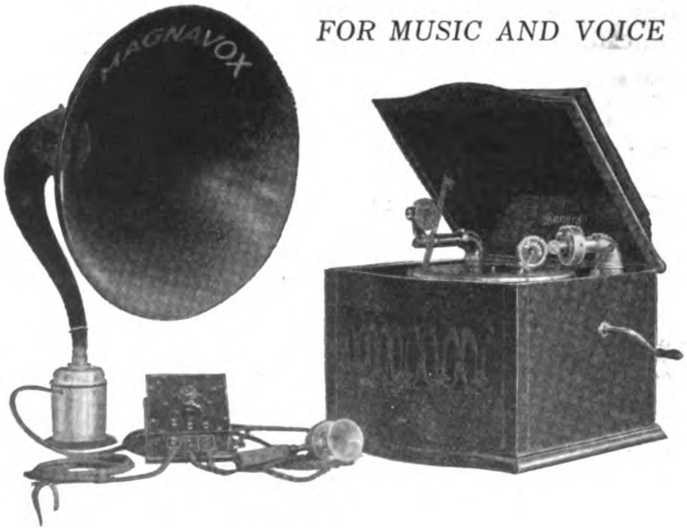

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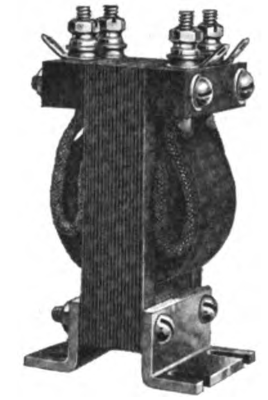

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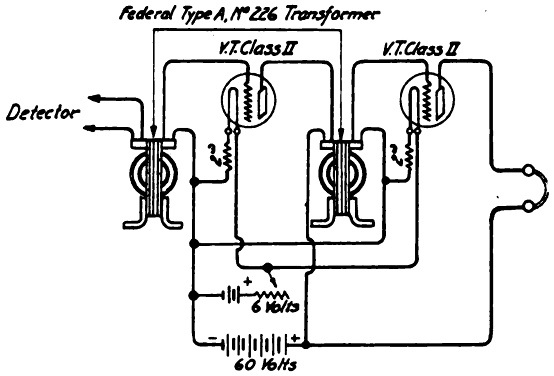

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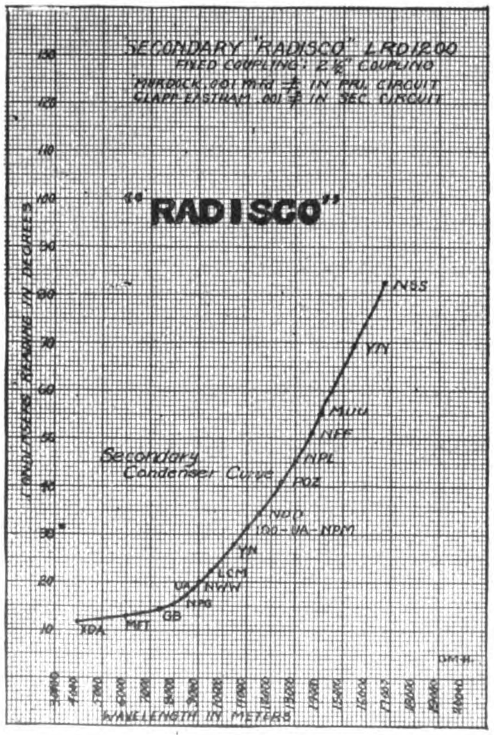

shows the performance of "RADISCO" long-wave coils used at Brookline, Mass., with a short amateur antenna. All the stations noted were received in several hours time—and but one tube was used.

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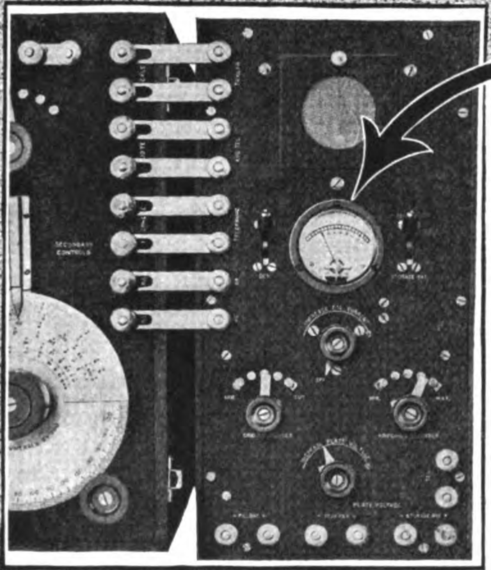

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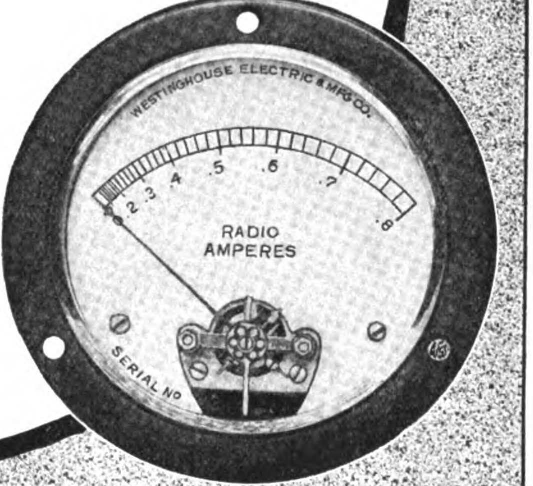

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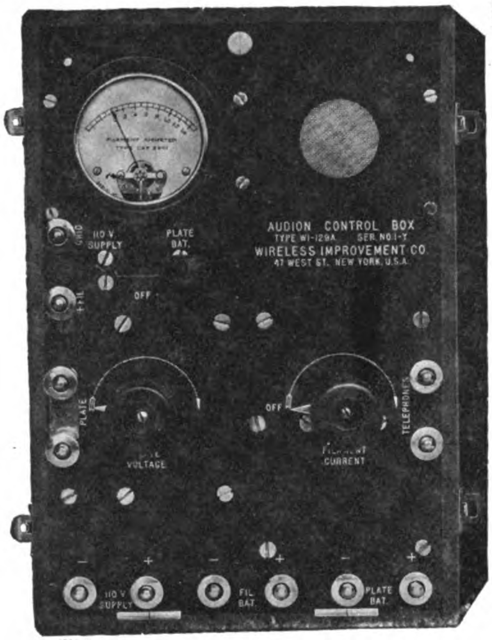

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TYPE WI-107A
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TYPE WI-111A
Single Vacuum Tube Base Socket.

TYPE WI-112A
Double Vacuum Tube Base Socket.

TYPE WI-114A
Triple Vacuum Tube Base Socket.

TYPE WI-120A
Grid Condenser. Small mica Dielectric condenser. Capacity: 0.0006 Mfd.

TYPE WI-121A
Telephone Condenser. Small Mica dielectric condenser. Capacity: 0.0025 Mfd.

TYPE WI-122A
Grid Leak Resistance. Glass enclosed. Moisture proof.

TYPE WI-126A
Crystal Detector. Dust proof—enclosed type.

TYPE WI-129A
Audion Control Box. Provided with filter system so that in addition to the plate battery of 40 volts, 110 volt supply may be used in the plate circuit.

On this page, in the next or subsequent issues, will be announced additional designs with their type numbers, etc., as well as other developments of interest to the art.

WIRELESS IMPROVEMENT COMPANY, Inc.
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If this page is cut out and appended to the same page cut from the editions to follow, a complete file of very interesting information will soon be available. (No. 1)

Vol. 7. No. 4. JANUARY, 1920

THE WIRELESS AGE

WORLD WIDE WIRELESS

Honors for E. F. W. Alexanderson

ERNST F. W. ALEXANDERSON consulting engineer of the General Electric Company, whose inventions have made possible the plan of the Radio Corporation of America to connect the nations of the world by wireless has just been doubly honored as the result of his remarkable achievements.

The Institute of Radio Engineers, an international organization, elected him vice-president and awarded him a handsome gold medal, "in recognition of distinguished service in radio communication in 1919."

Dr. Alexanderson has gained a world-wide fame in the inventive and radio fields. Of his many inventions more than one hundred are protected by patents in the United States and other countries. Foremost of these is his high frequency alternator, which makes possible the sending of one hundred words a minute by wireless, as compared with twenty under other conditions.

Dr. Alexanderson was born in Sweden, and is the son of Prof. A. M. Alexanderson. He was educated in institutions abroad and came to America in 1901, accepting employment with the C. & C. Electric Company of New Jersey. A year later he entered the drafting department of the General Electric Company. Two years later, in 1904, he was transferred to the engineering department of the company. His ability and many inventions soon won him promotion as consulting engineer in charge of radio work.

Radio Corporation of America Plans Commercial Wireless

OUTLINES of a plan which it is expected will eventually link the principal nations of the world into a comprehensive chain of commercial wireless communication were made known following the election of officers and directors of the Radio Corporation of America, the new corporation formed to acquire the Marconi interests in the United States with the support of the General Electric Company of Schenectady.

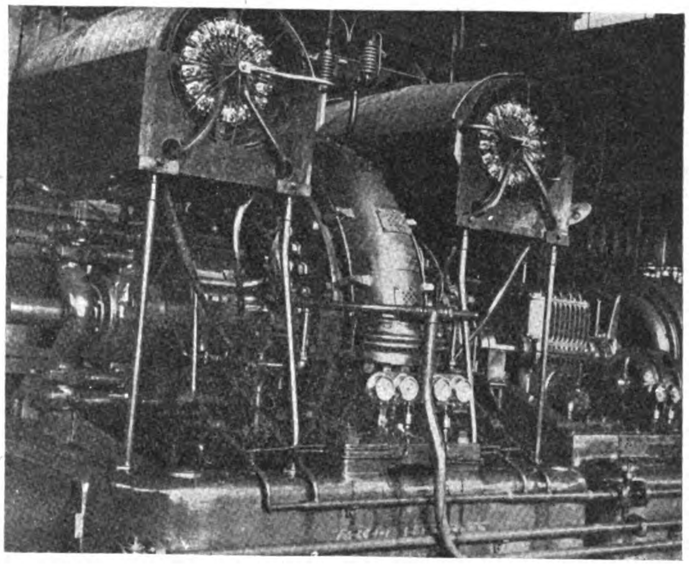
Edward J. Nally, who has devoted his life to communication service and who for a number of years has been vice-president and general manager of the Marconi Wireless Telegraph Company of America, has been elected president of the Radio Corporation.

Confirming the belief that the organization of the Radio Corporation will mean an immediate expansion of wireless development, the following statement, outlining the aims of the new company and planning the establishment of a world-wide commercial wireless service has been made by Mr. Nally:

"The principal aim and purpose of the Radio Corporation of America will be the establishment and maintenance of trans-oceanic and long distance overland communication.

"The Radio Corporation has been greatly strengthened through its connection with the General Electric Company by reason of which it will have available for its use the valuable wireless apparatus recently developed by the General Electric Company, the principal device being already widely known as the Alexanderson high-frequency alternator.

"Through agreements made with the Marconi's Wireless Telegraph Company, Ltd., of England, new powers and privileges are granted the Radio Corporation, extending its scope of activity and providing, among other things, for the formation of a South American company to be managed by it. The Radio Corporation will own the majority of stock in various companies which will construct stations in South America for communication with the United States and England, and in due course with other countries.



The New Brunswick high power station of the Radio Corporation of America, operated by the Navy during the war period, is well equipped to enable wireless to compete with the cables in trans-oceanic communication. The photo shows the giant 200-kw. high frequency alternator with dynamo at the right and the transformers on top

"It is confidently expected that this will be the forerunner of similar plans for the further extension of trans-oceanic wireless. Thus, the Radio Corporation of America, under traffic arrangements with the British company and others will be enabled, as soon as its stations are returned by the government, to start traffic with the British Isles, Norway, France and Japan in addition to the South American project already referred to.

"Under new conditions of financial strength, and in possession of the engineering resources of the General Electric Company, with a departmental staff of exceptional experience and ability, the company expects to attain the great objective for which it has always aimed, namely, a world-wide system of commercial wireless communication.

"In accordance with what is understood to be the wishes of the United States Government, effective means have been taken to see to it that the actual control of the Radio Corporation shall at all times remain in the hands of loyal American citizens or corporations."

Radio stations, which the corporation is waiting for the Government to relinquish control, are the transmitting station at New Brunswick and the receiving station at Belmar, N. J., which will be used for the British service; Marion, Mass., and Chatham, Cape Cod, sending and receiving for Scandinavian service, and Tuckerton, N. J., for sending and receiving from France. Hawaii, Japan and China operations will be conducted from Balinas and Marshal, near San Francisco.

Wireless a Boon to Americans at Constantinople

EVERY afternoon the wireless apparatus on the American cruiser Galveston, which has been lying in the Golden Horn at Constantinople for many weeks, catches from six to eight foolscap sheets full of news as it crosses the Atlantic for the United States, and every evening the day's crop is handed out to Americans and others thirsty for tidings of the outside world.

In the absence of a real local American newspaper the United States Naval Radio forms practically the only source of quick information. Sailor men do all the work and the more ambitious on the staff have started a cartoon supplement to the regular edition.

English Marconi Co. Increases Capital

FOLLOWING the sale of its holdings in the American company to the General Electric Company, Marconi's Wireless Telegraph Company, Ltd., London, has announced an increase in its capital. The official notice says: "At an extraordinary general meeting of the company a resolution was passed authorizing the increase of the company's capital by £1,500,000. On November 28, 1919, the confirmatory meeting was held.

"At these meetings the chairman informed you of the important and extensive developments of the company's business and the necessity for the substantial increase of the company's capital in order to provide for the commitments already entered into and to be ready to carry out the offer, if and when called upon to do so, which the company has made to the Government to construct and organize a thorough and efficient wireless telegraph service between all distant parts of the empire and the mother country.

"In these circumstances and for the reason which has already been given at the extraordinary general meeting, it was regarded as inexpedient to distribute a cash bonus to the shareholders, but a promise was made that this should be compensated for by the terms of the issue of the new capital.

"The directors have pleasure in informing you that in fulfilment of this promise they have decided to issue the whole of the increased capital to shareholders only at £2 per share premium. This will entitle every shareholder, whether he holds preference to ordinary shares, to secure one new share at the price of £3 for every share he may hold on December 4, 1919, when the register closed."

Lightships to Have Wireless

AS a measure of protection for the sturdy seamen who man the chain of lightships marking harbor entrances and shoal spots, the length of the two coastlines, the Lighthouse Board at Washington is considering installing wireless apparatus aboard each ship and it is probable that the plan will be put through in the immediate future.

The necessity for bringing these ships into radio communication with the land was brought home forcibly to the government two winters ago when Cross Rip Lightship was torn from her moorings in Nantucket Sound during a terrific storm and was swept to her doom carrying 10 men to watery graves. The tragedy has taken its place with the gruesome list of sea mysteries, for the ship was without means of communication to tell of her plight or to ask assistance.

To guard against a repetition of this disaster, the department is desirous of restoring wireless on each of the 67 lightships stationed far out to sea, keeping lonely vigils that shipping may be protected. During the war they were so equipped as to make possible the dispatch of warning of possible enemy raids on the coast. Last July the apparatus on all vessels was removed, excepting Nantucket and Cross Rip Lightships, which are stationed in exposed positions, and it was deemed advisable to have these two light vessels retain their outfits.

Gen. Squier's Report Praises American Radio Men

WHEN it came to war-time electrical inventions, especially those in the field of radio communication, American experts accomplished brilliant work and more than held their own with experts of the allies and the enemy powers, according to the annual report of Major General George O. Squier, chief signal officer of the Army.

"Invention in telegraphic and telephonic science reached its apparent climax in the perfection by American officers of the airplane telephone apparatus, whereby an aviator can communicate vocally with the earth or with other planes," Gen. Squier said.

The report, which throws light on many unrevealed incidents in the electrical side of the war, mentions that possibility of the enemy cutting all cable lines caused much concern in the early months of the war, and led to work being pushed on auxiliary radio stations, especially on the construction at Bordeaux of what was intended to be the longest-range station in the world. Discovery of the fact that it was possible to "tap" a cable without detection increased the anxiety of the government to complete the air communication lines.

The report records the unsuccessful search made in 1917 of the Atlantic coast for the secret enemy cable which, apparently authentic information said, had been laid by German submarines.

Wireless to Help Traffic Across Sahara Desert

THE army air service of France has been assigned the task of conquering the Sahara desert. The camel, conqueror of the desert wastes, must now defend his title and his right to monopoly in desert realms against the intrusion of the aeronaut, the French government announces.

The government hopes to establish postal, express and freight aerial routes through the whole length and breadth of the desert.

France's immediate object in the aerial conquest of the Sahara is to uplift the inhabitants of the border regions of the French colonial possessions of Algeria, Tunis and Morocco and of the French colonies along the western coast of Africa.

Major Vuelleman and Lieutenant Dagneux, the French aviators who recently flew to Constantinople, have been commissioned to work out the details of the project. They hope to be ready to establish regular flights early next spring.

The first lines will start from Algeria and will pass by the Oran peninsula to Timbuktu, the famous trading post in the southwestern part of the Sahara.

The flight will be divided into five stages. The first step will be about 600 miles, the second 400 miles, the third 250 miles, the fourth 500 miles and the last one a little over 600 miles.

In order to make the line permanent and in order to aid lines to be established in the future, the government will install sufficient wireless stations throughout the western Sahara to enable airplanes to keep in constant communication with at least one station.

Gasoline and oil stations will also be installed at each of the wireless posts. An automobile rescue service will be established which will enable rescue parties to search for airplanes the moment any are lost track of by the chain of wireless stations.

Sufficient police force to protect the aviators and passengers from savage tribes and from wild animals when planes are forced to descend in the wilderness will also be organized by the government. The government counts largely upon gaining the co-operation of friendly and partly civilized tribes in making the vast region safe for the aviators, and in keeping the country policed.

Immediately following the establishment of the initial line the government hopes to replace all of the camel caravan lines and to make the latter entirely unnecessary.

Negro Operator in Overseas Service

PERRY VAN DERZEE, Topeka, will sail for overseas service as a wireless operator, according to word received in Topeka by his father.

Perry Van Derzee is thought to be the only negro wireless operator holding a United States Government radio license. He is a graduate of three wireless schools.

Wireless Operator Loses Life in Storm

THE French steamer Madonna arriving here from Naples reported the loss of Chief Wireless Operator Bergis, who disappeared at the height of a storm during the trip. He left the bridge at 9 o'clock one morning to go to breakfast and is believed to have been washed overboard.

New Device Rings Bell to Call Wireless Operator

A REMARKABLE development of wireless was demonstrated recently at the Marconi headquarters at Chelmsford, England. An emergency calling device has been invented which enables a ship in distress to ring alarm bells on other ships within wireless range.

Up to now it has been necessary for every vessel carrying wireless to have an operator always "listening in." The new invention means that the wireless plant will need no more attention than an ordinary telephone.

A ship will "ring up" and the operator will then take the message. There will be no need for him to remain glued to his instrument all day.

British Wireless Station in Bermuda

THE British Government is to open a wireless station in Hamilton, Bermuda, for commercial business with Canada, the West Indies and the United States.

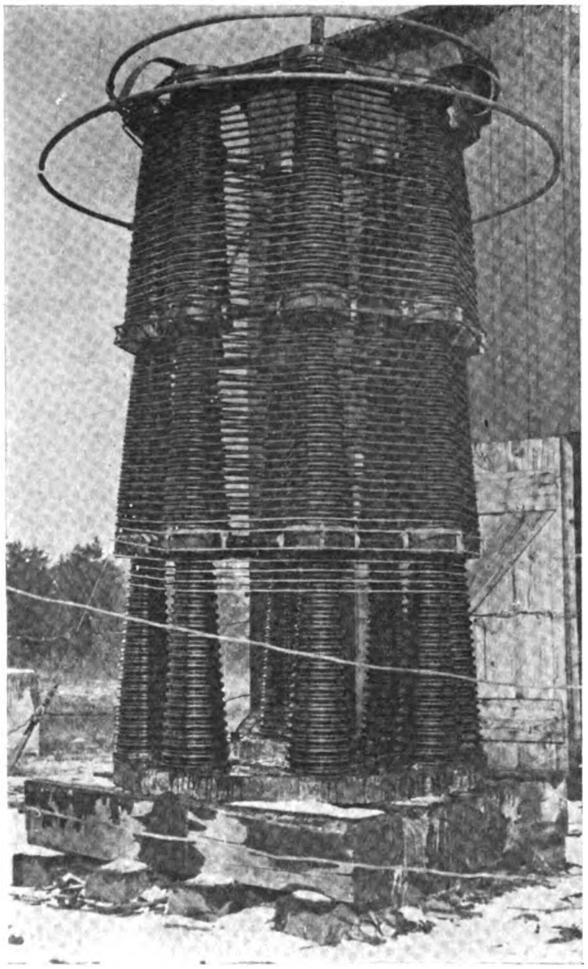
The colony will get one penny on each shilling of local business. The rate to Halifax will be one shilling a word.

French Adopt Wireless on Railroads

RAILWAY accidents have been so frequent and disastrous recently that French engineers after experimenting with new methods have installed a new system of railway signaling based on the principles of wireless telegraphy. The old system has always been considered good, but such speed has been attained by locomotives that it is now inefficient.

Another U. S. Radio Compass Station Erected

THE U. S. Naval Radio Compass Station at Surfside, Nantucket Island, latitude 41 deg. 14 min. 42 sec. North, longitude 70 deg. 05 min. 56 sec. West, call letters NBS, was placed in commission January 9, 1920, to furnish radio compass bearings to passing vessels.



Giant tuning coil at the New Brunswick high power station

Wireless Between Mexico and Chili Possible

THE possibility of establishing wireless communication between Mexico and Chili has been demonstrated in the most casual manner through the intercepting by the wireless station of the University of Santiago de Chili of more than 2,000 words sent from the Mexican station at Chapultepec.

The operator at the receiving station experienced not the slightest difficulty in the transcription of the message. This occurrence has been widely commented upon, as much in Mexican as in Chilean official circles, and it is hoped that within a short time it will be possible to establish a regular service between the two countries. In the last few days various messages have been exchanged with utmost clarity from Chapultepec to the University of Santiago de Chili.

Wireless in Foreign Trade

Its Valuable Influence in Promotion of International Commerce—Importance of The Radio Corporation of America. The New Company Which Combines the Marconi Activities With the Wireless Interests of The General Electric Company

THE post-bellum problems relating to commerce which are of special interest and pertinency to American business are those connected with the means whereby the international exchange of commodities which are produced or consumed by the United States may be enlarged and expanded. The war put upon the United States the responsibility of supplying foreign countries with amounts of American products in volume and value far beyond any previously conceived possibility or capacity. It did this, too, under the stress of most unfavorable conditions of transportation, of labor resources and of other necessary factors of commerce and industry.

It was a revelation to our own people of an unsuspected capacity for trade with the outside world, opened a vista of possibilities for commercial development such as had never been anticipated, and mirrored opportunities which American enterprise is eager to improve. Hence the wide discussion of the problems, methods, means and instrumentalities of foreign commerce in publications devoted to trade, finance or economics. Many of the questions involved have been argued and discussed from every conceivable angle, while others of equal importance have received very little consideration. Of this latter class none has greater influence upon success in establishing and maintaining foreign commerce than that connected with the means of communication between buyer and seller, principal and representative, in countries having international relations in commerce.

Trade Follows Communication

An old and familiar commercial adage tells us that "trade follows the flag." In a sense that is true, and it expresses a fact that is strongly emphasized in the efforts to build up an American merchant marine. But of much wider application is the equally correct statement that trade follows means of communication.

The main differences between foreign and domestic trade are those of time and distance, but chiefly time. "It takes two to make a bargain," and the bargain, to be satisfactory, should be explicit as to many details. "If you would come to a firm agreement with a man, meet him face to face," is a piece of advice not often physically followed in the transactions of international commerce. But it has been made intellectually possible by the magic touch of constructive science. The Marconigram is the effective medium which puts Tokio face to face with New York, or Buenos Ayres with Washington. And the same medium, capable of indefinite enlargement, is rapidly extending its sphere so that its expansion will keep pace with the broadening advance of America's foreign commerce. "World-wide Wireless" is already an accomplished fact, and its ramifications are rapidly being extended to cover the widest range of commercial need.

Why Wireless?

The importance of means of communication as a factor in the promotion of foreign commerce is so obvious that it needs no elaboration, but their quality and character are matters of considerable importance. The main requisites are that it shall be quick, reliable and as inexpensive as possible. Speed is the vital point in telegraphic communication on commercial affairs. "Do it now" stands first among the commandments of business diligence. Upon the basis of speed the Marconigram stands first among the factors of international communication, with less physical and mechanical impediments to rapid transmission than any other. Its accuracy is no less emphatic than its speed. The great improvements made to extend the range and amplify the resonance of the transmitting and receiving mechanisms of wireless telegraphy make radiograms the most reliable of all the methods of long-distance communication. The cost of wireless communication is considerably less than that of any other international service, and this makes it possible and profitable to use it much more liberally than any other systems the tolls of which are so onerous as to be prohibitive except in emergencies.

In wireless telegraphy, therefore, lies the hope of future satisfaction in the work of communication between the home and foreign fields of commerce. Wireless, as the efficient connecting link between port and port, the American manufacturer and the foreign consumer, the foreign representative and the home concern, broadens the outlook, makes straight the ways of communication and speeds up the transactions of international commerce.

Prompt Dispatch of Marconigrams

With the great revival and eager competitions of international commerce which have followed the World War there has come a demand for telegraph service which is unprecedentedly large. To the cable lines the demand has so taxed the capacity of the existing plants that they are in a state of chronic congestion, involving many delays in transmission that greatly reduce the value of the service. The demands on the Wireless have similarly increased, but the capacity of radio service is elastic where that of the cable is circumscribed, and it can be speeded up in the volume of work of which it is capable in a way to keep pace with every call upon it.

This elasticity of capacity is a strong factor in the influence which wireless telegraphy exerts, and which it will continue to exercise, over the expansion and welfare of American commerce with the nations of the world. Extensions of service as they may require enlargements of plant, can be effected with infinitely less expense than is involved in the laying of new lines of transoceanic cable. The potentialities of progress in wireless are practically unlimited to those who own and control the patented improvements that have made expansion possible. So that however great the need of extended facilities for transmission of messages overseas, the wireless service can be enlarged to meet it.

The Radio Corporation of America

The Marconi Wireless Telegraph Company of America, which built up for this country the wireless enterprise which gave to the United States its commercial wireless connection with Europe and the other continents, has recently been acquired by a new corporation, the Radio Corporation of America. That corporation acquired, in addition to the stations and wireless installations of the American Marconi Company, the manufacturing branch of business with its valuable American patents, the Marconi Institute for the training of radio men and all the property of that company, also all of the wireless interests of the General Electric Company, making it the most complete and best equipped radio organization in the world.

An American organization in every particular, the Radio Corporation of America is entirely independent of any other corporation, although it has traffic agreements with the British Marconi Company, the French Marconi Company, and the Governments of Norway and Japan. It has thus excellent facilities which make it the controller of a wireless service that is world-wide. It has stations on the Atlantic and Pacific Coasts of this country, and at Honolulu and Japan, for communications, via its Pacific Station, to the Hawaiian Islands, and the Far East.

WIRELESS TO SOUTH AMERICA

In addition to its installation in United States territory the Radio Corporation is organizing a new company to be called the Radio Corporation of South America, to cover South America with wireless installations which will give to the United States a direct means of wireless communication with South America. There can be no more valuable contribution to the great endeavor of American business to build up wider and better trade relations with the Southern Continent than will be offered by the enlarged and intimate connection to be afforded by this chain of wireless stations.

For the present the Radio Company of America is circumscribed in its opportunities and plans for service by the fact that its stations, taken over by the Government as a war measure, are not yet released to the company; but when that is done, which is expected to be soon, the corporation will be enabled to push to completion the plans and policies it has evolved for the widest possible extension of radio-electric service in aid of American commerce.

WIRELESS NEWS SERVICE AS FACTOR

Among the branches of useful service which indirectly, but none the less effectively, exerts a valuable influence in the promotion of American commerce, are the facilities the wireless offers for the dispatch of news, by means of which the newspapers of the various countries are and will be supplied with day-by-day information as to the various important happenings of each. Such interchange of information concerning the doings, the movements, the aspirations and achievements of various countries promotes an international knowledge which promotes friendly relations. With knowledge comes understanding, and the ability to see the point of view of the foreign business men.

Radio telegraphy, still in the infancy of its expansion, has reached an effectiveness of utility that is reflected in a constant increase in the demand for it. It was a great factor in the work of the war and new inventions to increase its efficiency resulted from the researches and inventions of many engineers whose discoveries are now included in the output of the Radio Corporation of America, for which the great works of the General Electric Company manufacture exclusively all of its radio equipment and devices.

POSSIBILITIES OF EXPANSION

The radio telegraph covers a much wider field than is possible to ordinary telegraphy. It links the steamship to the shore so that the shipowner and all interested in the vessel may be kept in constant and almost immediate communication with all on board. The character of the terrain between stations makes little difference in the installation of radio service: Desert, mountain, water, all are traversed by its messages. In other words the physical difficulties and the expense of maintenance of way, which figure so much in the upkeep of the ordinary telegraph lines, are entirely absent from that of the radio. It would be as easy to communicate with Kamchatka or Timbuctoo as with Chicago or Havana if business should justify the construction of a radio station of sufficient range at these remote places.

It is the adaptability of wireless telegraphy which gives it so much present influence and assures it a much larger share in the future promotion of international trade relations. As the demands of commerce grow, chains of wireless stations will put all the nations and every principal post and mart in each of them, in close and intimate touch with each other. We will know each other better when all civilized people are thus drawn together.

The filling of each other's commercial needs will be much more promptly and efficiently done when the touch of a button will bring buyer and seller together to expedite mutual exchanges of export and import. The sense of aloofness from foreigners and insular prejudices will disappear when the radio service has brought all lands together in commercial accord.

It is already the case that a very large part of the commercial world is already reached by radio service, that the larger vessels of all the modern mercantile fleets are made less isolated and immeasurably more secure through wireless installations.

The subject of wireless telegraphy, its achievements, its aims, and its plans, is one of widely diversified interest. Its success and further extension is important, from an American point of view, because of the things it has wrought, and the work it is doing, to aid in the development of this country's share in international commerce.

Don't Miss This——

A full description of a multi-stage amplifying receiver for short wavelengths. All the details of a set which brings in signals from amateur stations about ten times as loud as with a regenerative receiver and two-stage amplifier.

Communication between amateurs **across the entire continent** will become a regular thing with this set, and frequent "talks" with fellow amateurs in Holland and England will be made entirely possible.

——In the February Issue

Wireless in the A. E. F.

First Authentic Account of the Organization of the Radio Division of the Signal Corps and an Inside View of the Great Obstacles Which Americans Had to Overcome

By Lieut. Col. L. R. Krumm
Officer in Charge Radio Division, Signal Corps, A. E. F.
and Capt. Willis H. Taylor, Jr.
Co-ordination Officer, Radio Division, Signal Corps, A. E. F.

Part III

IT can reasonably be said that every move the enemy made after January, 1918, was observed and followed by American radio intercept, radio goniometric (compass stations) or ground listening stations. Intelligence of the greatest value concerning the enemy's plans and disposition of his troops was deduced from these intercepts and observations.

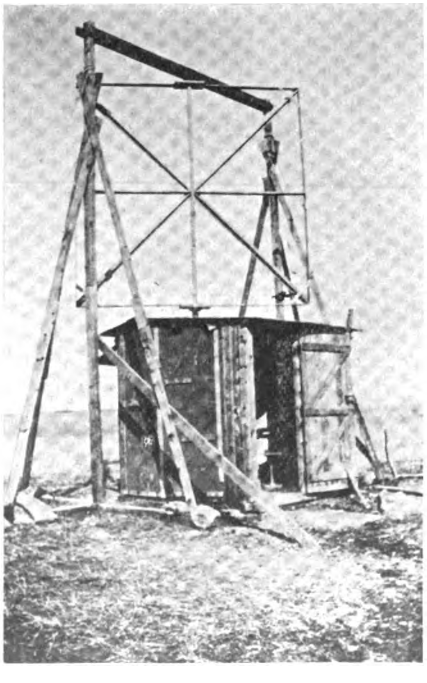
This source of information, so cleverly developed by the French and British, was utilized and improved to such an extent that toward the close of hostilities it was one of the most trustworthy aids to the operations of the American army. Information was obtained by these means which could not have been secured in any other manner, and the stations also continually served to check information received from other sources.

It was through information furnished by the radio goniometric stations that we had the ability to locate accurately every German radio station in the St. Mihiel salient on the days preceding the attack of September 12, 1918. The operation of the German stations furnished the only proof that the enemy had not withdrawn from the salient, and this proof—even in the face of overwhelming evidence to the contrary—prevented an eleventh hour change in the plans for the attack and a possible change in results.

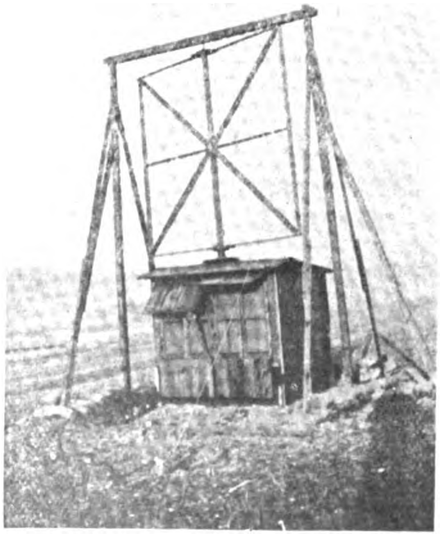
The operation of the radio intercept and radio goniometric stations and T. P. S. (ground telegraph) and wire telephone listening stations and the forwarding of all data to the Intelligence Section of the General Staff, A. E. F., was performed by the Radio Section (Intelligence) of the Radio Division, Signal Corps. In the words of the Intelligence Officer of the First American Army, "upon the efficiency of the Radio Section depended, in large part, the success of the Intelligence Section of the General Staff."

Unceasing vigilance was required of the officers and men of the Radio Section, together with the ability to meet the myriad ever-changing conditions. Too much credit cannot be given to the enlisted personnel. The trying conditions under which they labored, and the important results achieved by them were bywords to all who had knowledge of this service.

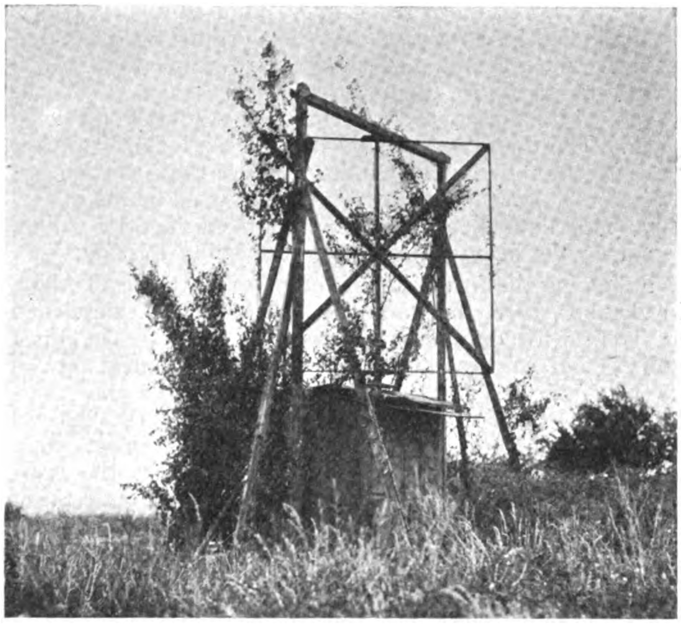
The Radio Section operated stations of six separate and distinct kinds, as follows: radio intercept stations which copied messages, generally in code, transmitted from German ground-radio stations; control stations which supervised the work of American radio stations and reported and stopped the use by our own forces of "clear" (uncoded) English and prevented other dangerous practices that might have served a useful purpose to the enemy; goniometric or radio compass stations which secured bearings on enemy radio stations, the


Radio goniometric station at Froidos in the Verdun sector

Radio intercept station at Ansauville in the Toul sector


Radio goniometric station at Landrecourt in the Verdun sector

transmittal of this data, enabling the Intelligence Section (General Staff) to accurately locate the stations geographically; airplane intercept stations which copied messages transmitted from enemy planes to the enemy ground radio station; airplane goniometric stations which located enemy observation and radio fire control airplanes and sent the bearings immediately to the Air Service, which in turn sent our pursuit planes to destroy or drive the enemy planes behind their lines; listening stations, which copied telephone and T. P. S. (ground telegraph) messages, thereby securing valuable information from enemy communications and at the same time policing our own telephone lines to see that dangerous conversation was not held over accidentally grounded circuits. The work of listening stations will be more fully described in another article of this series.


Camouflaged radio goniometric station on the Toul front

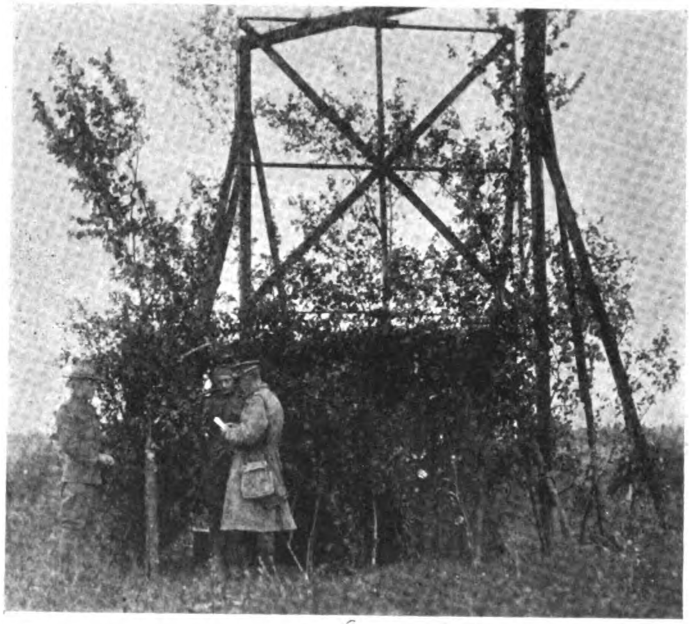
Before passing to the description of the apparatus used in the various types of stations and to outline the organization of the Radio Section (Intelligence), the following incidents may be of especial interest. They represent only a few of the many scoops that were made in addition to the daily confirmation of the enemy battle order, which may be briefly explained as the identification of the German units then in the trenches before us. Frequently the relief of a certain German unit was discovered before it had left the communication trenches.

On March 11, 1918, an entirely new code was put into service by the Germans. This was considered of great importance and indicated that the long-expected German attack would soon take place. All available officers and men of the Intelligence Section (General Staff) were assigned to its solution. On March 13, 1918, a message in an old solved code was intercepted by one of our radio intercept stations of the Radio Section (Intelligence). It was from a German radio station which had received a message in the new code and stated that the addressee was unable to read the message but asked that it be repeated in the old code. From the call letters given in this message it was possible to find the original message in the new code and the repetition in the old code, both having been copied. Comparison of the two gave a number of solutions which were at once communicated to the British and French intelligence sections. With this as a start, rapid solution was assured, so that before the Germans themselves were really familiar with their own new code it was being decoded by all of the Allies. The importance of the solution of this new German code can hardly be overestimated.

When it is considered that the message copied appeared to the radio intercept station operator simply as a series of letters without meaning, which is the hardest type of message to copy, and that in order to be sure of getting the valuable messages it was necessary to copy several hundred useless ones each day over long periods of time, also that the copying was done under difficult conditions and through interference which would have confused all but the best operators, then it will be possible to appreciate the fine work done by the men of the Radio Section. In this one instance a few minutes of inattention, a single mistake in call letters or the missing of a few groups of the code in one of the messages would have made the other useless. The American operators were the only ones who copied all three messages with sufficient accuracy to be useful, thereby enabling us to lay claim to the credit of performing this vital service for the Allies on the western front.

On the afternoon of April 24, 1918, a German message was intercepted from the St. Mihiel sector, announcing that an enemy attack had been postponed on account of bad weather. At 1.25 p. m. and again at 1.32 p. m on April 25, messages were again received ordering the German artillery batteries to remain at absolute attention and announcing that the barrage signal would be "BLUE." Our troops were notified and the necessary steps were taken to successfully combat the enemy raid which took place that night.

At 9.05 p. m. on April 28 a German message ordering an attack in the Toul sector at 1.00 a. m. was intercepted and telegraphed to the Intelligence Section (General Staff) decoding office, where it was decoded and our troops were warned thirty minutes before the attack. Without a well organized system for copying and transmitting these messages this information would have been received too late to have been useful. It should be noted that in this case, as in others, the radio intercept station operators had no knowledge of the important nature of the message.


Radio division officer inspecting a camouflaged goniometric station on the Toul front

Again on June 14, 1918, a German message was intercepted stating that the French were preparing an attack and giving instructions for meeting it. The French Army Staff was notified. We were later informed by the French that they had planned an attack at the designated point and that our information that the Germans were prepared for it enabled the French to take the necessary precautions.

The radio goniometric stations (radio compass stations), like the intercept stations, performed excellent work; in spite of daily changes in the call letters of enemy stations they located accurately nearly all the enemy radio stations. The care and accuracy shown by the operator enabled the Intelligence Section (General Staff) to follow the movements of the German stations with precision and certainty. These movements often disclosed the intentions of the enemy.

The first radio intercept and goniometric station at General Headquarters, A. E. F., at Chaumont

One case in particular is very interesting. Just before the American attack on the St. Mihiel salient there were many indications that the enemy had withdrawn and the advisability of advancing the infantry without artillery preparation was seriously considered. The final decision to make the attack as originally planned was based upon the observations made by radio goniometric stations that enemy radio stations were still active in their old locations.

The airplane radio intercept stations also gave an excellent account of themselves by reporting the location of enemy radio fire control airplanes working with the German artillery, enabling the various American Air Service Squadrons to interfere with many well planned hostile "shoots," as a local radio controlled artillery action was termed.

The first American radio intercept station was established at Souilly in December, 1917, at the Headquarters of the Second French Army, which was defending the Verdun sector. Due to the inexperience of the men it was difficult, at first, to obtain satisfactory results, but after a few weeks they became so proficient that the Intelligence Section of the Second French Army requested copies of all messages intercepted by this station. On New Year's Day, 1918, another intercept station was established at Souilly, one station serving to copy short-wave German stations and the other long-wave German stations. These stations were soon moved, one to Landrecourt and the other to Froidos, both towns being a short distance back of Verdun.

After the First Division had taken over a portion of the front northwest of Toul, intercept stations were established at Ansauville, eight kilometers from the battle front. After a few months of bombardment and gas in this location the stations were moved to Menil-la-Tour and then to Toul, where better wire connections to General Headquarters A. E. F. could be secured. In the meantime the radio intercept stations at Froidos and Landrecourt were moved back to Souilly, First Army Headquarters, where they remained until the advance of the First Army on the Argonne front made it necessary to move them forward.

Most of the radio intercept operators had their share of thrills. For two weeks the Germans were endeavoring to destroy an ammunition dump located about a quarter mile from the intercept station at Landrecourt and about six miles from the lines, requiring the Germans to use a heavy calibre gun to reach it. A number of these huge shells landed in close proximity to our stations, throwing shell fragments and stones into the station huts. The operators stuck to their posts during these bombardments, although no protection whatever was afforded them. The dump was finally hit and exploded, its force breaking the oiled cloth windows of the radio station hut and upsetting a storage battery on the head of the operator. This man thereupon showed his courage by calmly replacing the heavy battery and continuing to copy.

Following the formation of the Second American Army in October, 1918, the Radio Section Base was established at Toul, with detachments operating in both the First and Second Armies. The First Army detachment moved its headquarters and intercept stations to what was known as "Radio Hill," near Essey, while the Second Army detachment established stations and quarters in dugouts formerly occupied by the enemy, on the crest of an eminence six kilometers from the line and overlooking the entire front of the Second Army. When the First American army pushed ahead in the Argonne, the intercept stations at Souilly were moved forward and installed on the top of the citadel at Verdun. This location afforded a perfect target for the enemy artillery. Gas alarms were an everday occurrence, antennæ were cut down and the stations were showered with shrapnel.

The equipment in the radio intercept station comprised standard French radio intelligence apparatus, together with some specially designed Marconi receivers which gave excellent results. The French equipment was known by the following names:

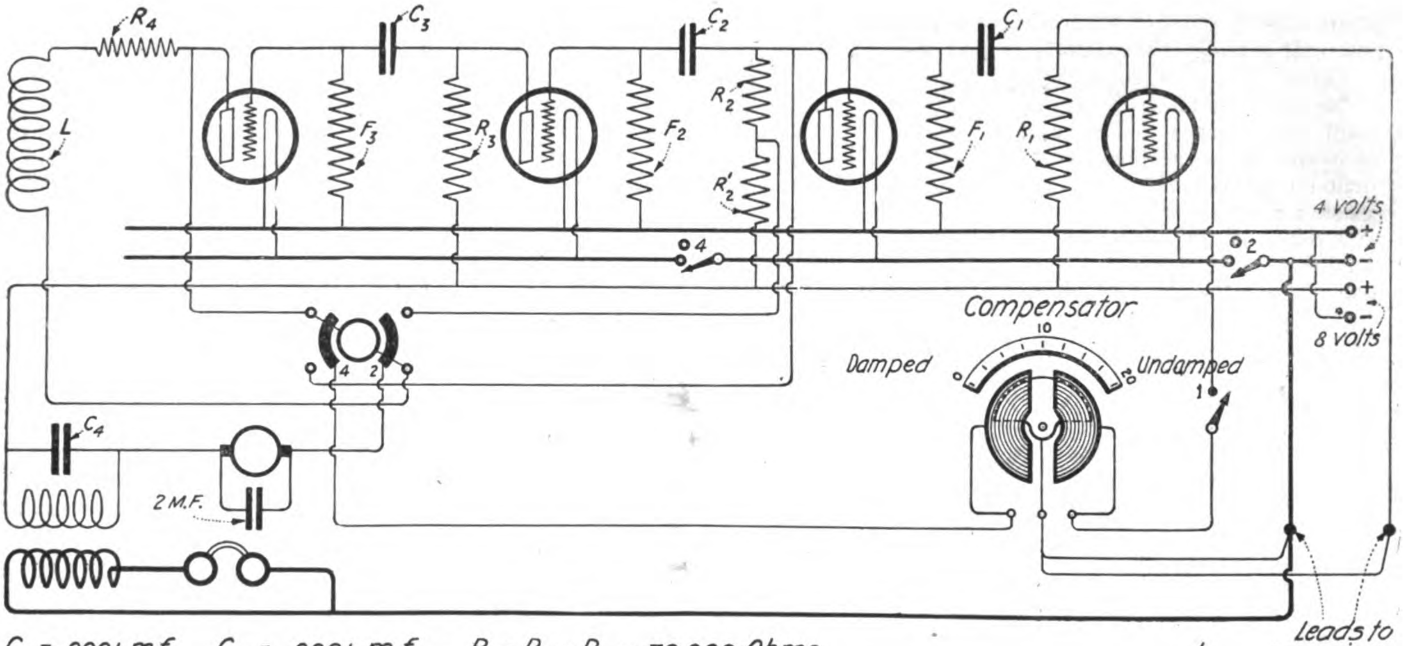
Fort Landrecourt forming portion of Verdun defense as seen from radio intelligence station at Landrecourt

Receiver Type No. 2.
Receiver Type No. 3.
Receiver Type A-1.
Amplifier Type 3-ter.
Amplifier Type L-3.
Amplifier Type R-2 bis.
Amplifier Type R-3 ter.
Wave Meter Type No. 2.

Receivers, Types No. 2 and No. 3, each consisted of a primary and secondary circuit made up of a variable

Radio goniometric stations on Toul front provided with small loops of American design

capacity and a variable inductance as shown in the circuit diagrams. The secondary of the Receiver Type No. 2 is arranged so that the coupling between the primary and secondary circuit may be varied by pulling out a movable section of the receiver box upon which the secondary inductance is mounted. A four-point switch on the panel makes it possible to connect the secondary circuit directly into the antenna for stand-by listening or to inductively couple it with the primary circuit for tuning purposes. Multi-point switches are provided for primary and secondary inductances by means of which the desired number of turns may be used in both the primary and secondary inductances respectively. Numerous auxiliary switches are provided on both multi-point switches to disconnect the unused portions of primary and secondary inductances in order to avoid the absorption of energy by setting up oscillation in such unused portions or dead ends. By means of two switches, fixed condensers may be connected in shunt with the variable condensers of the primary and secondary circuit.



$C_1 = .0001$ m.f. $C_3 = .0001$ m.f. $R_1 = R_2 = R_3 = 70{,}000$ Ohms

$C_2 = .25$ m.f. $C_4 = .004$ m.f. $F_1 = F_2 = F_3 = 5$ megohms Amplifier Type R_2^{bis}

Circuit diagram of Amplifier Type R-2 bis

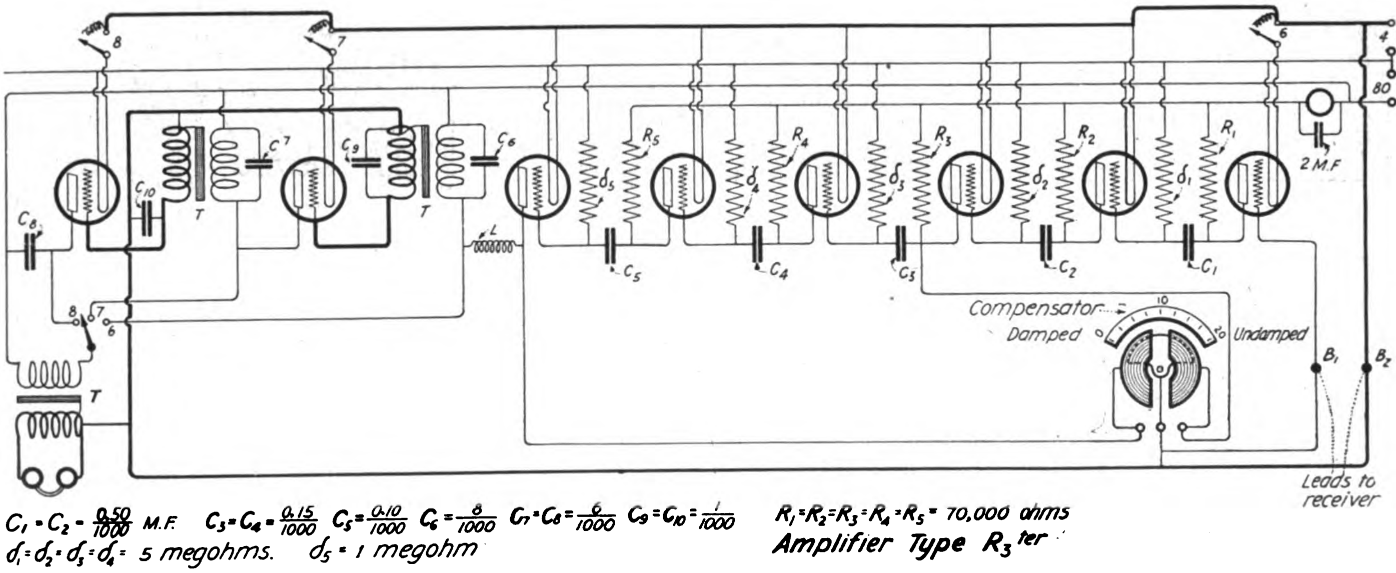
The Receiver Type No. 3 is similar in both electrical and mechanical construction to Receiver Type No. 2 with the exception that the coupling between the primary and the secondary inductances is varied by rotating a portion of the secondary inductance within the primary inductance. Receiver Type No. 2 is designed to be utilized on wave lengths from 150 meters to 6,000 meters and Receiver Type No. 3 from 300 meters to 15,000 meters.

Both the Receiver Type A-1 and the Amplifier Type 3-ter have been described in a previous article.

The Amplifier Type L-3 was used principally for receiving on loops; a description of this instrument will be given hereafter in connection with the radio goniometric station equipment.

Amplifier Type R-2 bis comprises four standard French vacuum tubes, as shown in the accompanying circuit diagram, coupled by means of high non-inductive resistances. All four tubes may be used in series, or the last two tubes may be cut out of the circuit. With four tubes it works best on wave lengths above 800 meters.

while with only two tubes in operation it may be used to receive efficiently wave lengths as low as 400 meters. The Amplifier R-2 bis was designed particularly for the reception of weak signals. The accompanying simplified circuit diagram will aid in an understanding of the complete diagram; all of the vacuum tubes being connected in the same way. In this diagram it will be seen that the grid is connected by means of a resistance to the positive lead of the 4-volt filament battery. The grid potential between the points C1 and C2 charges the grid condenser which in turn imparts its charge to the grid in the usual manner, giving rise to variations in the filament plate current. The plate is connected through the resistance R to the positive lead of the 80 volt plate filament circuit B battery. The potential drop through the resistance R therefore takes place in accordance with variations of the plate current and therefore high frequency amplified oscillations are available. There is also a simultaneous detecting action carried on and the proportion of the two effects depends upon the strength of the signals received. The high frequency amplifying effect will be preponderant for weak signals, while the detecting effect is the greater on strong signals. The result is that for the circuit arrangement described a single vacuum tube so connected will work well on strong signals as evidenced by the telephone, but it will not work well on weak signals, although the high frequency amplifying effect may be very great. This defect is avoided by connecting several vacuum tubes in series, the first vacuum tubes then acting as high frequency amplifiers for weak signals and the last one almost solely as a detector. It will therefore be observed that this amplifier is particularly adapted for receiving weak signals. It also aided considerably in eliminating strong static.


8
7
6
4 V
80 V.
C7
C9
C6
C10
C8
T
T
L
R5
R4
R3
R2
R1
δ5
δ4
δ3
δ2
δ1
C5
C4
C3
C2
C1
2 M.F
8
7
6
T
Compensator
Damped
10
20
Undamped
B1
B2
Leads to receiver
C1 = C2 = 0.50/1000 M.F. C3 = C4 = 0.15/1000 C5 = 0.10/1000 C6 = 8/1000 C7 = C8 = 6/1000 C9 = C10 = 1/1000
δ1 = δ2 = δ3 = δ4 = 5 megohms. δ5 = 1 megohm
R1 = R2 = R3 = R4 = R5 = 70,000 ohms
Amplifier Type R3 ter

Circuit diagram of amplifier Type R-3 ter

The amplifier R-2 bis is arranged to receive either damped or undamped waves. It is provided with what the French term a "compensator," which in our parlance is familiarly known as a "capacity feed back" or "regenerative coupling." Briefly, the purpose of this "compensator" is to maintain the production of high frequency local oscillations on the self-heterodyne principle, when receiving undamped waves. When four tubes are used it couples the plate of the fourth tube back in the grid of the first tube, while it couples the plate of the second tube in the grid of the first tube when only two tubes are used. The compensator's pointer should be to the right when receiving undamped waves and to the left when receiving damped waves.

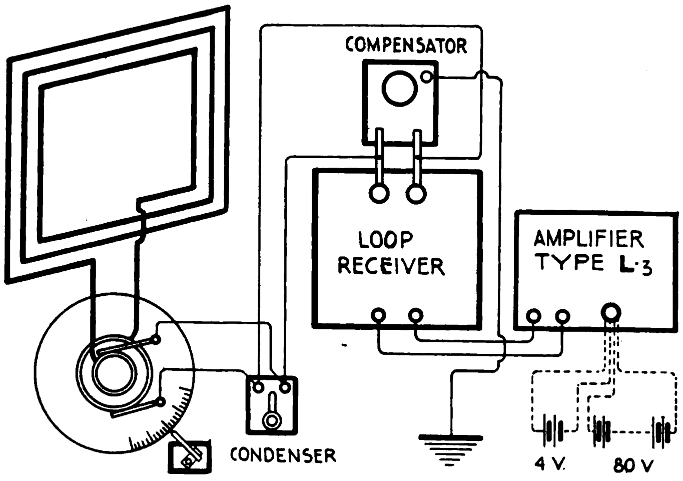
The Amplifier Type R-3 ter is very similar electrically to Amplifier Type R-2 bis, as will be observed from the accompanying diagram, but it has six steps of high-frequency amplification and two steps of low frequency amplification. This makes a total of eight standard French

Operator copying short wave length radio intercepts in Toul sector

Locating German field station in a radiogoniometric station on the Toul front

Copying coded German messages in a long wave length radio intercept station on the Toul sector vacuum tubes used in its construction. As in the Amplifier Type R-2 bis, the last vacuum tube of the high frequency amplifier serves as a detector. The two last vacuum tubes serve only as low frequency amplifiers of the amplified and rectified audible frequency signal impulses.

This amplifier may be used to receive signals on wave lengths varying from 2,000 meters to 20,000 meters for either damped or undamped waves. Further explanation of the function of the so-called compensator will be omitted, as it has been explained in connection with the Amplifier R-2 bis. Attention is directed, however, to the fact that when undamped waves are to be received the plate of the sixth vacuum tube is coupled back to the grid of the first tube.



Circuit diagram of a radiogoniometric station

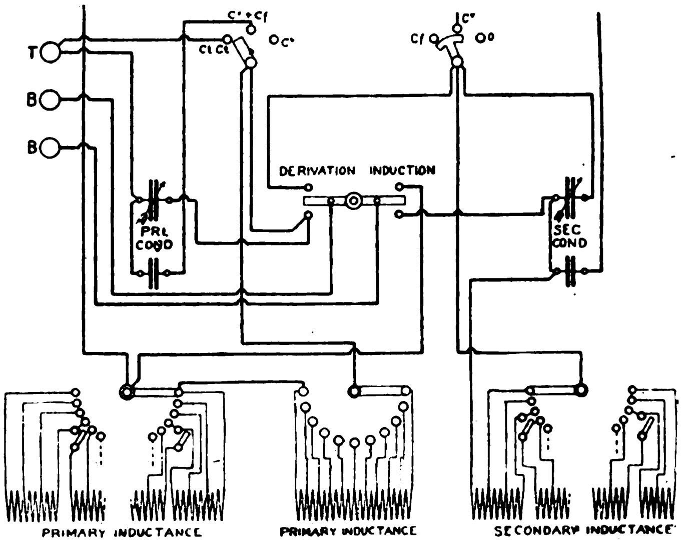
Provision is also made in Amplifier Type R-3 ter to utilize a variable number of vacuum tubes. A switch is provided whereby six, seven or eight lamps may be utilized, which means that no low-frequency amplification may be provided or that one or two steps may be used in accordance with the desires of the operator.

The most generally used wavemeter for calibration purposes in radio intercept stations was that known as Wave-Meter Type No. 2, and it was adapted to be used for a wave length range of 150 meters to 1700 meters. A few of the novel features of this wave-meter will be observed in the accompanying circuit diagram. The calibrated circuit comprises two inductances, the first in three sections and a variable condenser with a pointer moving over an arc graduated in wave lengths. Three scales of wave length are engraved on the arc, corresponding to the cases when one, two or three sections of the first inductance are connected into the calibrated circuit. The buzzer circuit is closely coupled with the first inductance of the calibrated circuit, serving to set up oscillations in it. By means of a double switch the coupling coil of the buzzer circuit may be cut out and the buzzer be made to serve as a "tikker," periodically breaking and closing the calibrated circuit, for the detection of undamped waves. The detector circuit has two coils wound on the same spool placed inside the first inductance of the calibrated circuit. A double, three-way switch makes it possible, first, to connect the two coils in series opposing for measurements of emitted waves (position Em); secondly, to connect in one coil alone for the reception of short waves (position PO); third, to connect the two coils in series, aiding for the reception of long waves (position GO). An auxiliary coil which can be connected into the antenna circuit more or less closely with the calibrated circuit is made up of two coils, the second of which is used for increasing the coupling for the longest waves.

The service performed by the radio goniometric stations was closely allied with that of the radio intercept stations, inasmuch as the determination of the point of origin of a German message which had been copied by our radio intercept stations aided the Intelligence Section of the General Staff in the preparation of their charts of German radio activity and helped to locate the concentration of German troops in different sections of the line.

The work done by our radio goniometric stations was greatly facilitated by the adoption of a small revolving frame to replace the somewhat cumbersome French frame. The smaller frame was found to be much easier to rotate, especially while working in a heavy wind. The operators were enabled in this way to obtain more bearings, with improved accuracy, while the intensity of the signals remained about the same.

In addition to our radio intercept stations radio goniometric stations were established at Froidos and Landrecout during January, 1918, and in March a station was installed at Ansauville in the Toul sector. The Ansauville goniometric station being located in a very dangerous position, it was later moved back to Menil-la-Tour. This station while at Ansauville and Menil-la-Tour was the first radio goniometric station operated by Americans in an "All American Sector." During an attack on the Toul front on May 27, 1918, it was operated by two men for the 24 hours of a day and took 650 bearings, thus establishing a record that was never subsequently beaten or even equaled. To understand what this figure means, one should have had actual experience in operating a gonio. In order to take one bearing it is necessary to tune in the calling station by manipulating the adjusting knobs of the loop receiver with one hand, while rotating the revolving frame with the other to find the two points of silence, in the meantime noting the call letters, tune and points of silence, then figuring the mean of these. The wave-length and intensity of signals have to be determined, and whether a message or a call was sent, and in addition a record made of all this data. Two Radio Section men did this at an average of one every two minutes for eight hours!

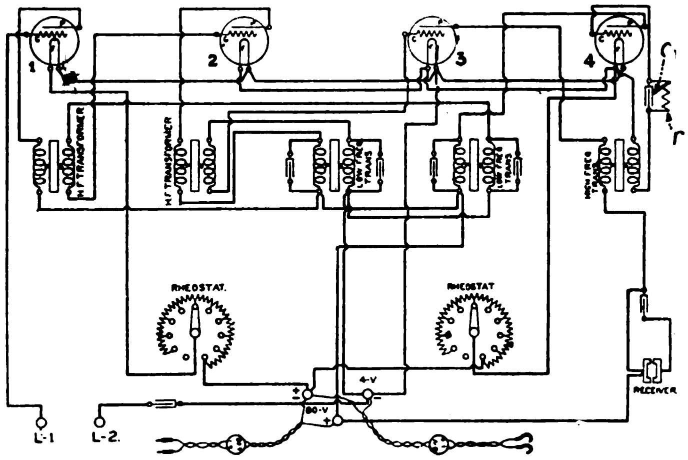


Circuit diagram of Receiver Type No. 2

The first radio goniometric station in the Toul sector having proven so successful, three of these stations were established in July, 1918, along the front taken over by the American Army in the Toul sector. The stations were located at Royaumeix, Cornieville and Saizerais.

Also in July, 1918, three radio goniometric stations were taken over from the French Eighth Army and operated by personnel comprising both French and American soldiers. These stations were located at Tomblaine, Luneville and Brouville.

In anticipation of open warfare, the American 2 kw. automobile tractor radio sets were converted into mobile radio goniometric stations and equipped with Radio Set Type E-3 bis. The first of these tractors proved so useful that two more tractors were rebuilt as described. In the St. Mihiel drive they proved of great value. One was stationed at Cornieville, one at Royaumeix, and one at Saizerais. The readings of all stations were transmitted by radio and, as the attack progressed, the Cornieville tractor advanced and took a more forward position at Hattonville. The tractors were afterward sent to the Verdun sector, where they continued their excellent work.



Circuit diagram of Amplifier Type L-3

In the latter part of September, 1918, the goniometric stations of the French at Voncourt and Wombey, in the Verdun sector, were taken over from the French. These stations gave good results under American control until the St. Mihiel drive left them stranded, as the operators expressed it—in the "Service of Supplies."

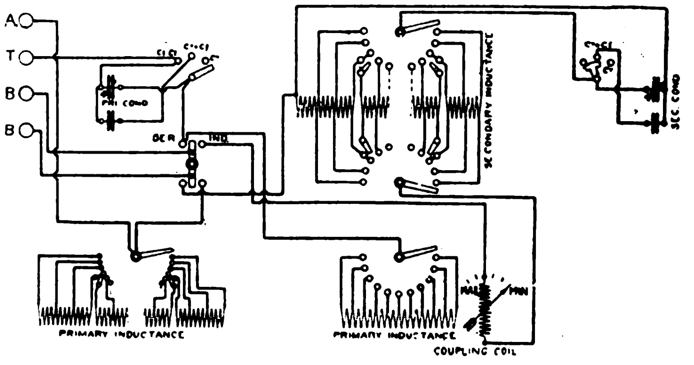
The three radio goniometric tractors moved from the Toul sector to the Verdun sector were stationed at Ville-sur-Taube, Avecourt and Verdun. In co-operation with three French radio goniometric tractors they covered the advancing front extending from the western edge of the Argonne to the right of the First American Army east of Verdun. They were later supplemented by a permanent station at Verdun. Reports from the "gonio tractors" were transmitted by radio to the P. C. T., located at First Army Headquarters, and to the Headquarters of the Second American Army on our right and to the Headquarters of the Fourth French Army on our left. The rapidity of the advance kept the tractors continually on the move, and oftentimes they worked as far as 75 kilometers from their base in the shell-torn and gas drenched territory just back of the fighting line.

The equipment used in both the permanent and tractor radio-goniometric stations was standard French radio equipment for the most part and was identified as follows: Goniometric station, complete, comprised a loop receiver—Type No. 2 or No. 3 Loop Compensator, and Amplifier Type L-3. A portable wooden hut was supplied to house the instruments and provide shelter for the operators.

The apparatus of the goniometric station was connected up in accordance with the accompanying schematic diagram. The hut and equipment served as a semi-permanent station for the reception of radio signals having wave lengths between 250 and 1400 meters, and for simultaneously determining the direction from which they were sent. Two such stations working in conjunction served to locate approximately the sending stations by means of simple triangulation. The loop, which is about ten feet square, is mounted above the roof on the end of a heavy wooden shaft, and can be rotated by means of a hand wheel attached to the shaft inside the hut. The lighter and smaller loops previously described were much easier to rotate.

The loop consisted of three turns of wire and the signals were received in the loop and loop receiver circuit, which was in turn connected to the amplifier that detected the signals. A German transmitting station having been picked up, the loop was rotated until a position was found in which the signals became inaudible; approaching this position alternately from opposite directions, an average position of minimum audibility was found, which gave approximately the direction from which the waves were coming; when the signal was faintest the plane of the loop was known to be perpendicular to the direction from which the signal was coming. If at first no position of complete silence was obtained, the loop compensator was used and successive adjustments of the compensator and plane of the loop were made until complete silence was obtained. An oriented pointer and a dial on the loop shaft indicated the geographic bearings for all positions of the loop.

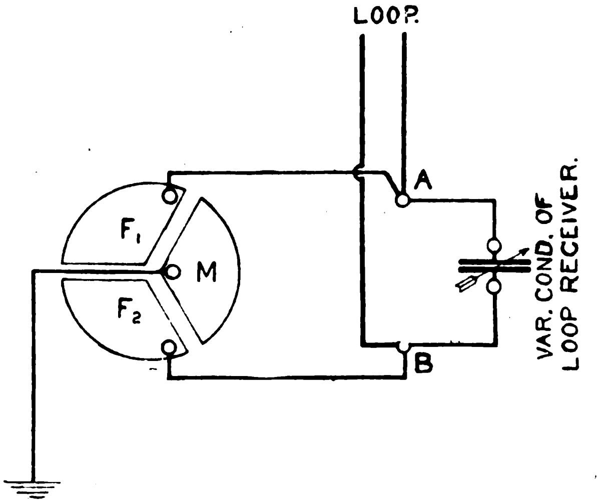
The Loop Receivers Types No. 2 and 3 comprised only variable condensers, together with either one or two fixed condensers; in the circuit diagram herewith they are illustrated in conjunction with the loop compensator. The loop compensator was used to correct the inequality of the capacities of the two leads to the loop with respect to the ground. The loop compensator is simply an air condenser with three sets of plates, two fixed and one movable. The fixed plates are connected respectively to the two-loop leads through the loop receiver while the movable plate is grounded. It is therefore possible, by rotating the grounded plates, to equalize the capacities of the leads of the loop to a certain extent. This adjustment is good for any wave-length, but it is extremely critical with reference to the position of the operator and any masses of metal and other similar effects.



Circuit diagram of Receiver Type No. 3

The Amplifier Type L-3 was designed for receiving signals on wave lengths ranging from 200 to 1,000 meters. It makes use of four standard French vacuum tubes, as will be seen from the accompanying circuit diagram. The first three tubes act as high frequency amplifiers. The fourth tube, in which the grid is connected to the positive lead of the filament by means of a conductor, in which is placed a condenser C shunted by a high resistance R, acts as a detector. The low frequency detected current is again amplified by the second and third tubes.

The first "high frequency" part of the apparatus forms an amplifier with a transformer having thin sheet iron cores. High frequency currents flow through the transformer marked HF. The amplified currents flow through the condensers, shuting the windings of the low frequency transformers, whose impedance is very high for high frequencies, but which permits the flow of the continuous component of the filament-plate current. For currents of audible frequency the capacity of the condensers is greater than the reactance of the transformers. The low-frequency currents therefore flow through the transformer windings and are amplified by the second and third tubes as in an ordinary low-frequency amplifier.



Circuit diagram showing use of loop compensator in radiogoniometric stations

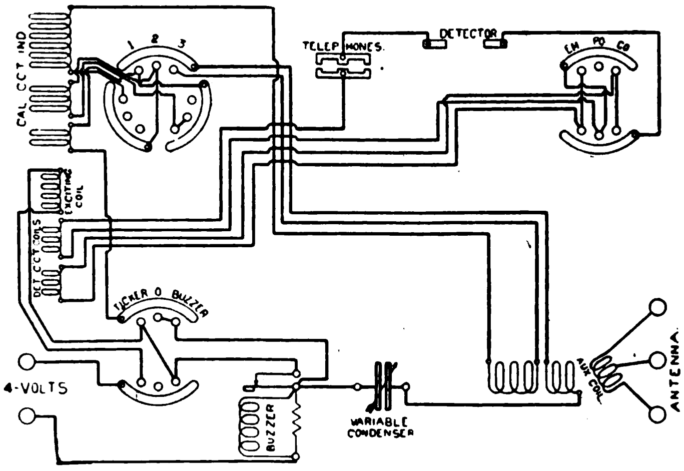
The number of messages sent in "clear" English—uncoded—and other violations of the radio regulations of the A. E. F., demonstrated the need for stations which specialized in copying messages transmitted by American field stations. Two control intercept stations of this character were established at Toul in July, 1918. One station copied damped wave-signals and the other station copied undamped wave-signals. When the First Army Headquarters moved to Souilly, two undamped wave-control stations were put into operation to supervise the work of American operators in that sector; by promptly reporting messages sent in "clear" they on several occasions succeeded in suppressing this dangerous form of radio communication.

At the time that the chain of radio goniometric stations were established along the Toul front airplane radio intercept stations were installed at Royaumeix and Tomblaine. From Royaumeix a special telephone line to Toul was used to send "alerts" to the Air Service, and similar direct connections were provided from Tomblaine to French Air Service pursuit squadrons. The radio goniometric stations generally took bearings only on German field radio stations, but when an enemy airplane was picked up by the special airplane radio intercept station all radio goniometric stations were notified and bearings were immediately taken to determine the position of the Hun plane. This work was unusually successful, and many hostile airplanes, directing their artillery by radio, were interrupted in their mission by the appearance of American pursuit planes which were enabled to fly directly to the approximate location of the German plane. The record of enemy airplane flights, the signals sent, and the portion of the front over which the German planes operated, was of great assistance to the Intelligence Section (General Staff) in compiling their charts of hostile airplane activity.

In the Verdun sector a combined airplane radio intercept and airplane radio goniometric station was able to locate many hostile airplanes, and by means of a special telegraph wire it was possible to immediately give notification of an enemy radio fire control airplane calling its battery. The Intelligence Section (General Staff) was usually able to identify the German artillery battery about to fire and notify the proper counter battery commander. Our artillery was often able to counteract the German artillery fire, sometimes even before it had really started its intense fire.

A press and general radio intercept station was established early in the fall of 1917 at American General Headquarters in Chaumont. This station copied all European press messages and communiques, as well as nearly all commercial and official business transacted between the Central Powers and neutral countries Inasmuch as Nauen (POZ) carried on much suspicious high speed transmission with Spain—ascertained by copying the corrections transmitted by hand of the high-speed message text—plans had been made to install high speed reception apparatus at this station, but the armistice intervened.

This article would not be complete without recording the service rendered by Major Robert Loghry. He was untiring in his efforts and was largely responsible for the excellent results obtained by the Radio Section. Nor would this article be complete unless acknowledgment was made to the French Army for the results obtained by our Radio Section. By furnishing equipment and radio stations and especially by the personal assistance given by the French army radio intelligence officers, the American Radio Section was able to reach a state of high operating efficiency in a short time which otherwise would have been impossible.



Circuit diagram of wave meters—Types Nos. 2 and 3

The fourth instalment of "Wireless in the A. E. F." will appear in an early issue of the Wireless Age.

Frequency Transformation

IN an invention of Ernst F. W. Alexanderson a method of transforming an alternating current of a given frequency and of utilizing the current thus transformed for radio signaling purposes is described.

Numerous systems have been heretofore proposed for transforming an alternating current of fundamental frequency into an alternating current of a frequency harmonic to the fundamental frequency. In some of these systems means have been provided for distorting the wave of the current of fundamental frequency from the sine wave form in such a way that certain harmonics are made prominent and these harmonics have been segregated in circuits which are particularly harmonic or harmonics which are to be utilized.

In prior systems of the type in question it has been customary to tune the circuit of the fundamental frequency by means of a condenser in series with the source of supply and the iron core inductance which has been employed for distorting the wave form. Such a circuit has a tendency to become unstable and in order to operate the same in a practical way it must be adjusted so that a substantially constant load is supplied from the source of energy whether current is being supplied to the utilization system or not. One of the objects of this invention is to overcome this difficulty by providing a system which does not tend to become unstable and in which the energy drawn from the source of supply will be a minimum when no current of harmonic frequency is being supplied to the utilization system.

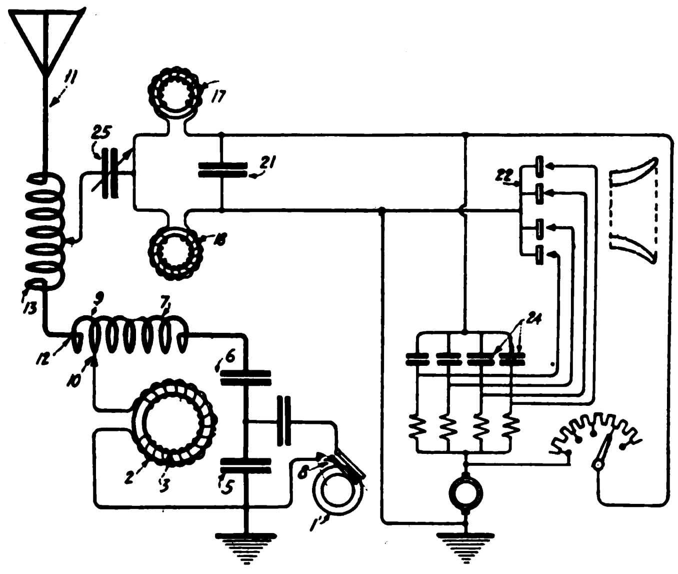


Figure 1—Circuit of the Alexanderson method of transforming the frequency of alternating currents for radio signaling

In carrying out this object, a capacity of such value as to compensate for the inductions on the circuit at no-load is provided. As a result, when no energy is being withdrawn from the system the only current flowing therein will be a circulating current between the capacity and inductance and the only energy required for maintaining this current will be that required to supply the energy losses of the circuit.

As indicated in the drawing, a source of energy, which in the present case is an alternating current generator, supplies current to the winding of the iron core 3. A condenser in series with the alternator compensates for the internal inductance of the alternator. Condenser 5 in shunt to the alternator is of such value as to compensate for the inductance of the winding 2. The condenser 6, which is in series with the alternator, is of such value as to compensate for the inductance 7, which is also in series with the alternator. With the system thus far described it will be apparent that the capacity 5 will draw a lagging current from the alternator and the inductance 2 will draw an equal lagging current, so that when no current is supplied to the radiating system the actual energy which the alternator is required to supply will be merely the energy required to make up the losses in the circuit. In utilizing this circuit arrangement for supplying current of harmonic frequency to a radiating system the terminal 8 of the alternator is grounded and the point 10 between inductances 7 and 9 is connected to the antenna 11. The effect of connecting the radiating system in this way is the same as shunting the inductance 2 by a resistance and hence the alternator 1 will be required to supply additional energy for maintaining current in the radiating system. For various reasons it is undesirable when current of a harmonic frequency is supplied to the antenna that current of the fundamental frequency should also flow in the antenna. In order to prevent this the inductance 9 is arranged in inductive relation to the inductance 7 and so proportioned that the point 12 at the end of this inductance is of substantially the same potential with respect to the fundamental frequency as the earth connection. In other words, there is a potential of fundamental frequency impressed upon the harmonic frequency circuit which is equal and opposite to that impressed upon the inductance 2 from the source 1. This being the case there is no tendency for current of the fundamental frequency to flow in the antenna. The antenna circuit is tuned by means of the usual variable inductance to the harmonic frequency which it is desired to utilize. With the arrangement here shown any desired odd harmonic of the fundamental frequency may be caused to flow in the antenna. If it were desired to utilize an even harmonic, it would be necessary to employ a source of direct current for saturating the core 3. The inductance 7 offers a high impedance to current of the harmonic frequency and hence but little current of harmonic frequency will flow in the fundamental frequency circuit. The condenser 5 will offer a low impedance to current of the harmonic frequency and most of the harmonic frequency current which does flow through inductance 7 will pass through condenser 5 instead of flowing through the alternator.

In order to control the amplitude of the antenna current to produce signals a shunt circuit may be provided to the antenna and the impedance of this circuit varied in accordance with the signals which are to be produced. In the present case a system has been illustrated whereby the antenna current may be varied to produce telephonic signals. The shunt circuit mentioned is connected to any suitable point in the loading inductance 13 and comprises a magnetic amplifier or controller. In the present instance the specific form of amplifier used consists of two iron cores with windings thereon, these two windings being connected in parallel with each other in the shunt circuit. Current for producing a normal saturation of the cores may be derived from a direct current generator which is connected in series with the windings, as indicated. A resistance may be inserted in this circuit in order to adjust the saturation current desired for the most efficient operation. The condenser 21 is of such value as to offer a comparatively low impedance to the high frequency current but effectually prevents short circuiting of the controlling current through the windings. A steady current from the generator is also caused to flow through the multiple microphone 22. The field winding of the alternator 1 is divided up into four separate parts and the current which flows through the microphone is led through these separate parts of the field winding so that the field winding acts as a steadying inductance for the current through the microphone. When the microphone is acted upon by sound waves a variable potential is produced across its terminals and this variable potential is applied to the windings 17 and 18, in order to vary the saturation in their cores and thus vary the impedance of the shunt circuit. This variable potential is applied through the condensers 24, which prevent the short circuiting of the steadying microphone current. Condenser 25 in the shunt circuit is so adjusted that the circuit becomes resonant when the antenna current is a minimum.

Duplex Wireless System

IT is well known that in wireless telegraphy and telephony the magnitude of the transmitted current is enormously greater than the received current, their ratio sometimes being of the order of one million to one. This enormous ratio renders inapplicable to wireless systems duplex methods which have been successfully employed in wire telegraph and telephone systems.

It is further well known that static or atmospheric interference not only constitutes a serious menace to the successful commercial operation of wireless systems, but also that its elimination presents a very difficult problem. This difficulty inheres in the fact that the natural or characteristic oscillations, set up in a receiving system by a static disturbance, are of substantially the frequency to most strongly affect the receiving device, and that, therefore, static interference cannot be turned out by a change of wavelength, as can persistent interference from a foreign sending station. As regards the elimination of static interference, this invention, the work of John Mills and John R. Carson, does not attempt to reduce or eliminate the radio-frequency natural oscillations, but by interposing detectors between a receiving device and the seat of said radio frequency oscillations, resultant low frequency oscillations are developed which by a combination of circuits are balanced out with respect to the receiving device. In the several embodiments of the invention in duplex systems, it is contemplated that the system be resonantly responsive to two frequencies, one of which is that of the signals to be received, and the other is that at which signals are transmitted.

The invention may best be understood by reference to the accompanying drawing.

Referring to Figure 1, 1 is an antenna for the radiation and reception of energy, said antenna containing the primary of an oscillation transformer 30, which couples said antenna with the transmitting apparatus, conventionally represented by a high frequency generator 29. The antenna system has a plurality of branches in parallel, it being grounded through three parallel branch circuits, 2, 3 and 4. The branch circuit 4, which may be termed the transmission branch circuit, is tuned to resonance at the transmission frequency, and said branch circuit therefore offers a very low impedance to currents of said frequency. Branch circuit 4 contains a tuning inductance 13, a tuning condenser 14, and an anti-resonant set 8 which is tuned to anti-resonance at the reception frequency. The branch circuit 2, which may be termed the reception branch circuit, contains a tuning condenser 10, a coupling coil 9, and a set 5 which is adjusted for anti-resonance at the transmission frequency. By means of the tuning condenser and coupling coil, the circuit consisting of the antenna in series with the branch

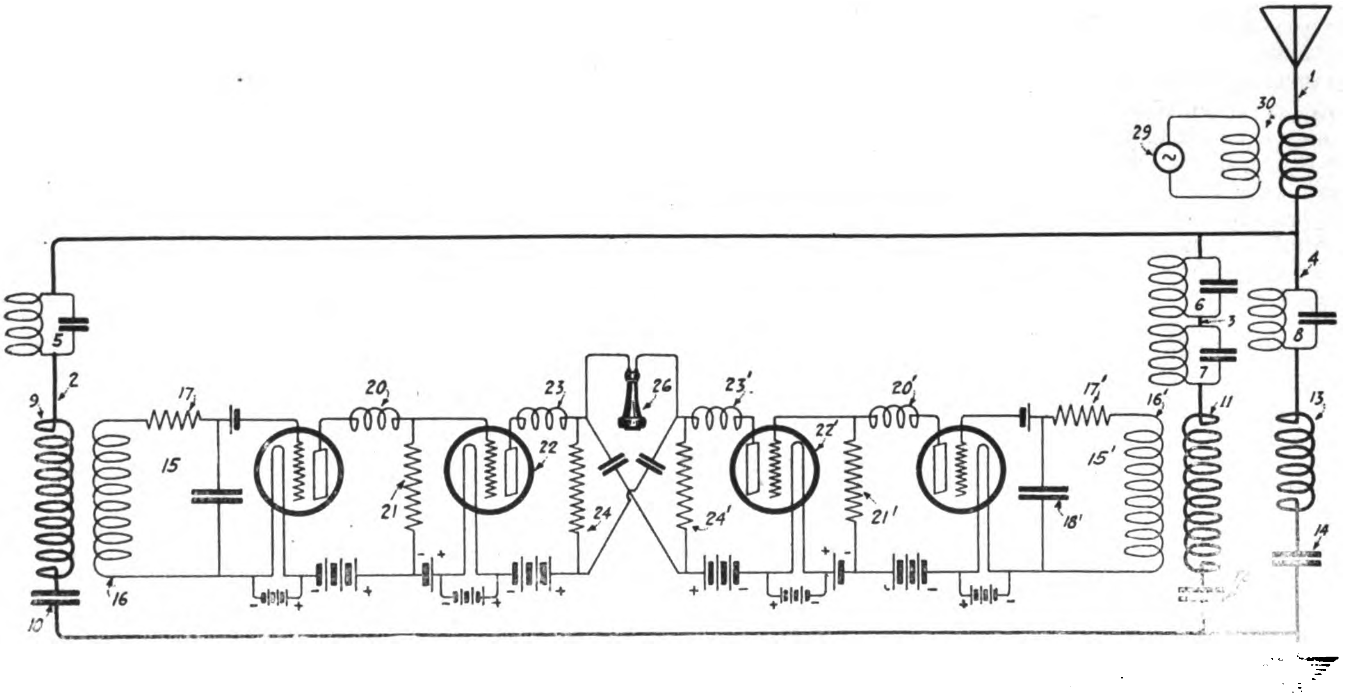


Figure 1—Circuit of the duplex wireless system which develops low frequency oscillations that are balanced out

circuit 2 is tuned to resonance at the frequency of reception. It will thus be understood that circuit 2 offers a very high impedance to the transmission currents and is adjusted for maximum response to the signals to be received. Branch circuit 3, which may be termed the auxiliary branch circuit, contains a coupling coil 11, a tuning condenser 12, and two sets 6 and 7, the first of which is anti-resonant to the reception frequency and the second is anti-resonant to the transmission frequency. The branch circuit, 3, therefore, offers a very high impedance both to current of transmission and current of reception wavelength. It is evident that the organization thus far described has a plurality of degrees of freedom and that as a whole it is resonantly responsive to two frequencies, one of which is the frequency of transmission and the other the frequency of reception. It is further evident that the circuit consisting of the antenna in series with branch 4 as well as branch 4 itself is resonant at the transmission frequency. It follows from the principles of electrodynamics that there is a third frequency at which branch 3 is most responsive, since the system as a whole has three degrees of freedom.

A receiving device, conventionally represented by a telephone receiver 26, is connected in a symmetrical manner both to branch 2 and branch 3 through amplifiers (preferably of the vacuum tube type), detectors (also preferably of the vacuum tube type), and the loosely coupled oscillation circuits. The oscillation circuit 15 contains a coupling coil 16, a condenser and a resistance element 17, and is tuned to the frequency of reception. The circuit 15′ correspondingly contains the elements 16′, 18′ and 17′, and is tuned to the frequency to which the branch 3 is responsive; 20, 23, 20′, 23′ represent high inductance impedance elements, while 21, 24, 21′, 24′ represent non-inductive resistance elements.

The operation of the organization shown in the figure will now be explained. Considering first the phenomena of transmission, it has been already stated that branch 4 offers a very low impedance to the transmission currents, while branches 2 and 3 are substantially anti-resonant at the transmission frequency; it therefore follows that practically all the transmission current flows through the branch 4, and only a very small fraction thereof through branches 2 and 3. However, owing to the enormous ratio of the transmitted and received currents, the fraction of the transmission current flowing through the branch 2, if only one part in one hundred thousand of the total transmission current, will still be much greater than the current excited by electromagnetic waves from the communicating station. It will be seen then that in spite of its high impedance to the transmitted current the oscillation circuit 15 may be excited more strongly by the said transmission current than by the relatively very small reception current to which 15 is tuned to respond. Except for the branch 3 and its associated apparatus, it may well be that in spite of careful design and sharp anti-resonance, the currents set up in the receiver 26 by the transmission current will be prohibitively large. One of the functions of branch 3 and its associated apparatus is, however, to substantially eliminate the transmission interference in a manner now to be explained. Since branches 2 and 3 both contain elements or sets which are anti-resonant at the transmission frequency, they offer substantially the same impedance to the transmission currents. Therefore approximately equal fractions of the transmission current flow through branches 2 and 3 respectively, and the effects of the current in circuits 15 and 15′ are, therefore, excited by equal induction from branches 2 and 3, respectively, and the effects of the current in circuits 15 and 15′ after translation and amplification oppose and may be made to substantially neutralize with respect to the receiver 26. When this condition is attained, it is evident that no current corresponding to the transmission current flows through the receiver 26, and therefore, the organization satisfies the fundamental condition for duplex operation, namely, freedom from transmission interference.

As regards now the phenomena attending the reception of signals from the communicating station it is evident that, by virtue of the anti-resonance of branches 1 and 3 to the reception frequency, the system is essentially the same as though branches 1 and 3 were removed, leaving the antenna grounded through the circuit consisting of the antenna in series with branch 2 and the oscillation circuit 15, which are separately tuned to the reception frequency. Therefore circuit 15 oscillates strongly in response to the received signals, while circuit 15′ oscillates very feebly. The current, corresponding to the received signals and flowing through the receiver 26, is essentially independent of the presence of branch 3 and its associated apparatus as well as of branch 4, and hence the arrangement shown is such as to satisfy the condition of efficient reception of signals.

The operation of the circuit shown in the figure in reducing static interference is as follows: When the receiving system as a whole is excited in its characteristic or natural modes of damaged oscillations, the predominant oscillation excited by the static disturbance in circuit 15 is practically determined as regards periodicity and damping by the electrical constants of the circuit, that is, by the values of its inductance, capacity and resistance elements. Similarly, the corresponding oscillation of circuit 15′ is determined by the electrical constants of the circuit. The predominant oscillations occurring in circuits 15 and 15′ will be of different frequencies, since these circuits are tuned to different frequencies; but such oscillations may be made to have the same damping factors by assigning suitable values to the inductance and resistance elements of these circuits. If the two damping factors are proportioned for equality, the voltages impressed on resistances 24 and 24′ will be of similar form and practically independent of the frequency of the natural oscillations, owing to the translating action of the detectors 19 and 19′ and the high inductive impedance of the inductance elements 20, 23, 20′, 23′. If the voltages impressed on resistances 24 and 24′ are equal and similar, the resultant current in the receiver 26 is zero. These voltages may be made equal in a number of ways, such as by proportioning the relative amplifying powers of the amplifiers 22 and 22′, or the relative values of the inductances 9 and 11. As regards static elimination the embodiment of the invention shown in the figure contemplates having the receiving device operatively connected to two parallel antenna branches, the receiving device being so connected to these parallel branches that the high frequency natural oscillations, after translation by detectors or after translation and amplification, oppose and substantially neutralize with respect to the receiving device.

It should be observed that in order that static interference shall be substantially eliminated it is essential that the oscillation circuits 15 and 15′ shall have practically the same time factors in order that the natural oscillations executed by the two circuits shall have the same damping. To this end it is necessary that

$$\frac{R}{L} = \frac{R'}{L'}$$

when R and L are the resistance and inductance respectively of circuit 15 and R′ and L′ the resistance and inductance respectively of circuit 15′.

Method of Signaling With an Arc

A METHOD of signaling for use in conjunction with an arc wherein the arc is extinguished and re-ignited, has been developed by Roland G. Marx and Leonard F. Fuller. The method described in their invention requires the handling of relatively small currents. With reference to the drawings, Figure 1 shows the scheme of connection and Figure 2 is a diagrammatic representation of the potential curve across the arc. In Figure 2 the potential curve 2 taken across the arc is a very irregular curve having sharp peaks 3, without which the arc cannot oscillate, and means are provided for robbing the potential curve of these peaks. When the curve is so robbed of its peaks the arc is extinguished and radiant energy is not emitted from the antenna circuit. Signaling is accomplished by alternately extinguishing and relighting the arc at telegraphic speed.

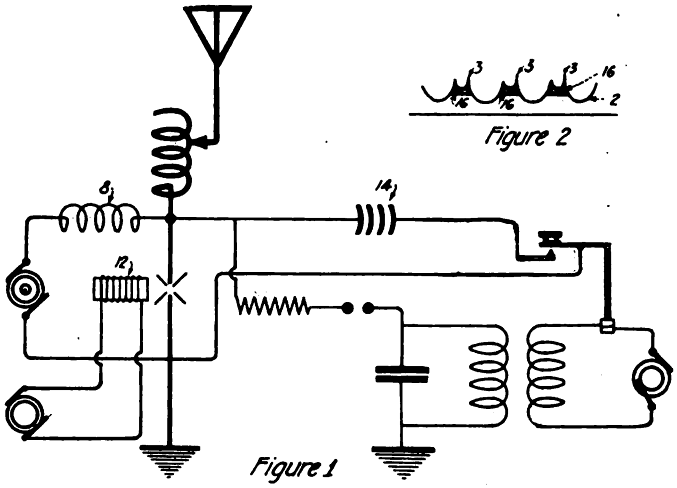


Figure 1—Circuit used in the arc method of signaling. Figure 2—Potential curve across the arc

The transmission system comprises an arc oscillation generator which is grounded on one side, preferably the negative, and connected on the other side to the antenna through a variable inductance or loading coil. Direct current is supplied to the arc oscillation generator by a generator and a choke coil 8 is arranged in the lead connected to the antenna side of the arc. The arc is subjected to a strong transverse magnetic field produced by the magnet coil 12, which may be separately excited by a generator.

The potential wave produced by the arc has a very jagged form, developing sharp peaks, and the wave may be robbed of these peaks at the arc or in the loading coil. This jagged wave form is impressed upon the first few turns of the antenna loading coil. In Figure 1 is shown the means for robbing the wave form of its peaks.

Connected across the arc is a circuit containing an electrolytic lightning arrester 14, which acts as a potential valve, and a signaling key. The lightning arrester is made up of two or more aluminum cells, connected in series, each cell consisting of two aluminum plates on which has been formed, by chemical or electro-chemical processes, a film of hydroxid of aluminum, the plates being immersed in a suitable electrolyte. When the jagged wave form is impressed on the arrester, the film opens, as it were, and a current limited only by the internal resistance of the cells, which is low, flows through the arrester. The part of the potential curve eliminated by the cells is indicated by the shaded portions 16 of the potential curve. When the signaling key is closed the wave form is robbed of its potential peaks which discharge through the aluminum lightning arrester and the arc is extinguished.

Ordinarily, when the key circuit is again opened, the arc will not re-ignite and means should be provided for re-igniting the arc immediately, so that the key may be operated at telegraphic speed. One form of means which may be employed for re-igniting the arc is shown herein, this form being so arranged that the arc is ignited as the lightning arrester circuit is opened. Connected across the arc is a spark circuit containing a spark gap, the secondary of the transformer and a capacity shunting the secondary. A stopping resistance is arranged between the spark gap and the antenna side of the arc to prevent direct current sufficient to maintain an arc across the spark gap from following the radio frequency current across the spark gap and passing through the secondary. The primary of the transformer is in series with an alternating current generator and a switch in the primary circuit is attached to the key by an insulating rod. When the lightning arrester circuit is opened, the circuit through the primary is closed, producing a high potential in the spark circuit and producing a spark across the spark gap which sets up radio frequency surges that ignite the arc.

Antenna Construction

ALTHOUGH it is very usual, in radio telegraphy, to place large inductances at the base of the antenna, and although several inventors have suggested placing inductance coils at the top of the antenna, inductance coils have never yet been distributed along the same line in order to increase the wavelength of the wire. Marius C. A. LaTour finds that it is possible to distribute inductance coils in this way along the antenna wire even under conditions compatible with the mechanical overloading that these coils will impose upon the wire. With this end in view, these coils may be arranged in the neighborhood of transverse struts. But, on the other hand, they may be constructed in such a way as to be extremely light. The drawings show one of the constructional forms of LaTour's invention. Figure 1 shows a portion of an antenna in the wires of which several coils have been distributed. These coils will preferably be constructed with magnetic circuits of iron or any other magnetic material. Figure 2 gives an example of a method of constructing these coils. They may consist merely of sheet iron discs cemented onto the antenna wire, but are otherwise insulated from one another by means of a coating of varnish or any other suitable insulating material. In general, that quality of iron will be employed which gives the lowest losses by hysteresis and by Foucault currents.

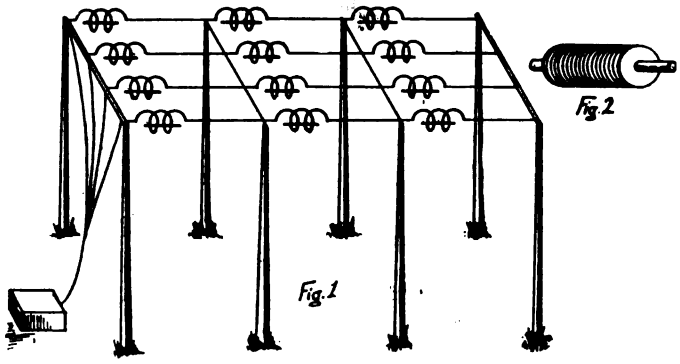


Figure 1—Antenna with inductance coils in place. Figure 2—Construction of the coils

EXPERIMENTERS' WORLD

Views of readers on subjects and specific problems they would like to have discussed in this department will be appreciated by the Editor

V. T. Detector and Four Stage Amplifier Resistance Coupled

By Charles R. Leutz

DURING the coming amateur radio season the best records will be made through the medium of efficient receivers and reliable V. T. amplifiers.

Many good receivers have been described and the writer feels that the amateurs will welcome information dealing with an amplifier suitable for use in connection with any receiver.

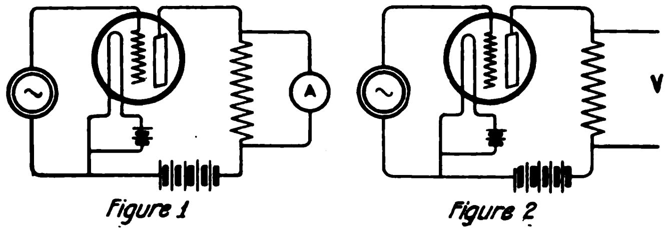


Figure 1 *Figure 2*

Circuits used to give the proper values of V. T's.

Those amateurs who have experimented with transformer coupled amplifiers find that great difficulties are encountered due to "singing," when more than two stages are used. This "singing" is due to generation of audio frequency oscillations at frequencies depending upon the inductance and capacities associated with the circuit. When using resistance coupling instead of transformer coupling this "singing" is not so great, and although the amplification factor of a single transformer coupled amplifier is greater than that of a single resistance coupled amplifier, the resulting overall amplification factor—using maximum number of tubes without "singing"—is considerably greater with a properly constructed resistance coupled amplifier.

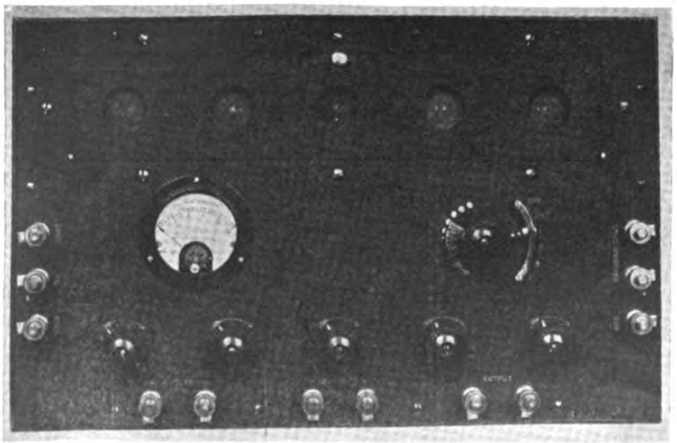


Figure 3—Complete amplifier and detector panel set

A few words in regard to the fundamental action of a resistance coupled amplifier may be in place. With reference to Figure 1, suppose that an alternating E. M. F. is impressed between the grid and filament of a V. T., and that A is an absorbing circuit; the resistance R is varied over wide limits, keeping the plate potential constant. If readings were taken they would show that the maximum energy in the absorbing circuit would exist when the resistance of the absorbing circuit equaled the internal resistance of the V.T. This maximum output would vary with plate potential, because the internal resistance of the V.T. varies with plate potential.

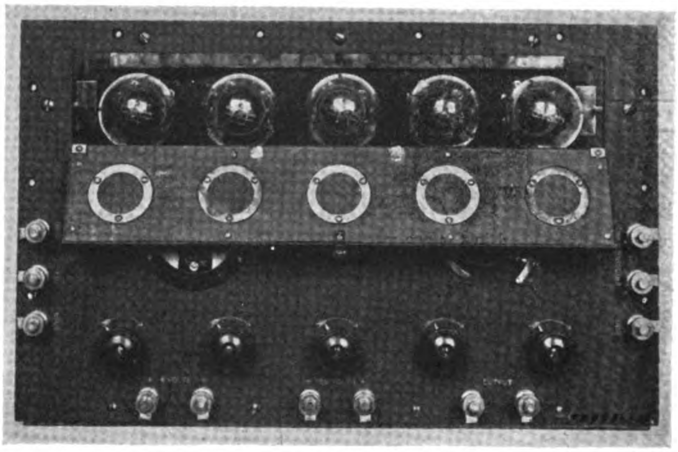


Figure 4—Showing the window panel with copper gauze windows opened to permit removal of V. T's.

However, as the audion is a potentially operated device, we want the maximum voltage across R instead of the maximum current in the absorbing circuit in all steps but the last, and the last step the nearer the impedance of the telephone is to the impedance of the V. T., the greater the efficiency.

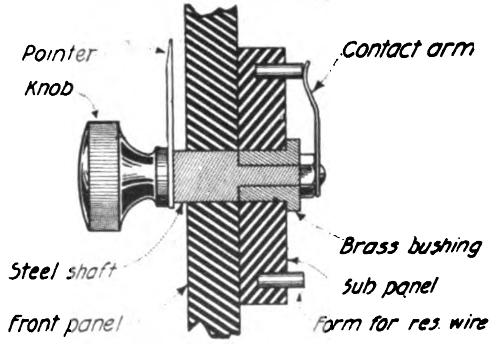


Figure 5—Showing the construction of the filament rheostat

With reference to figure 2, by varying R we find that for each differently constructed V.T. and for a given plate voltage, there is a definite resistance which will give the maximum voltage across that resistance. These experiments have been worked out and the proper values are given for Marconi V.T.'s in the following data:

Figure 3 shows a completed amplifier and detector. A window panel is at the top to allow replacement of burned out V.T.'s. This panel is shown open in Figure 4. In the window panel are copper gauze windows, so that the brilliancy of the filaments may be noted with the door shut. To prevent coupling (capacity) from the head telephones to the first V.T. through the operator's body, all the parts of the amplifier are enclosed in the case, which is copper lined. The telephone leads are covered with a flexible copper sheathing and the sheathing connected to the copper lining of the amplifier case.

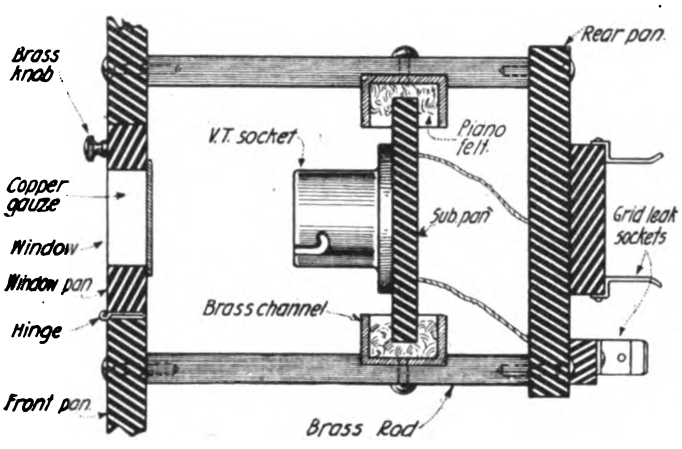


Figure 6—Section showing V. T. holder and shock proof construction

A switch is provided to cut in as many stages of amplification as is necessary, at the same time automatically lighting the filaments of the V.T.'s, which are used. The construction of this switch is clearly shown in the photograph. The dimensions can be chosen by the amateur, as in the case of the completed amplifier. This particular instrument was about eighteen by twelve by nine inches.

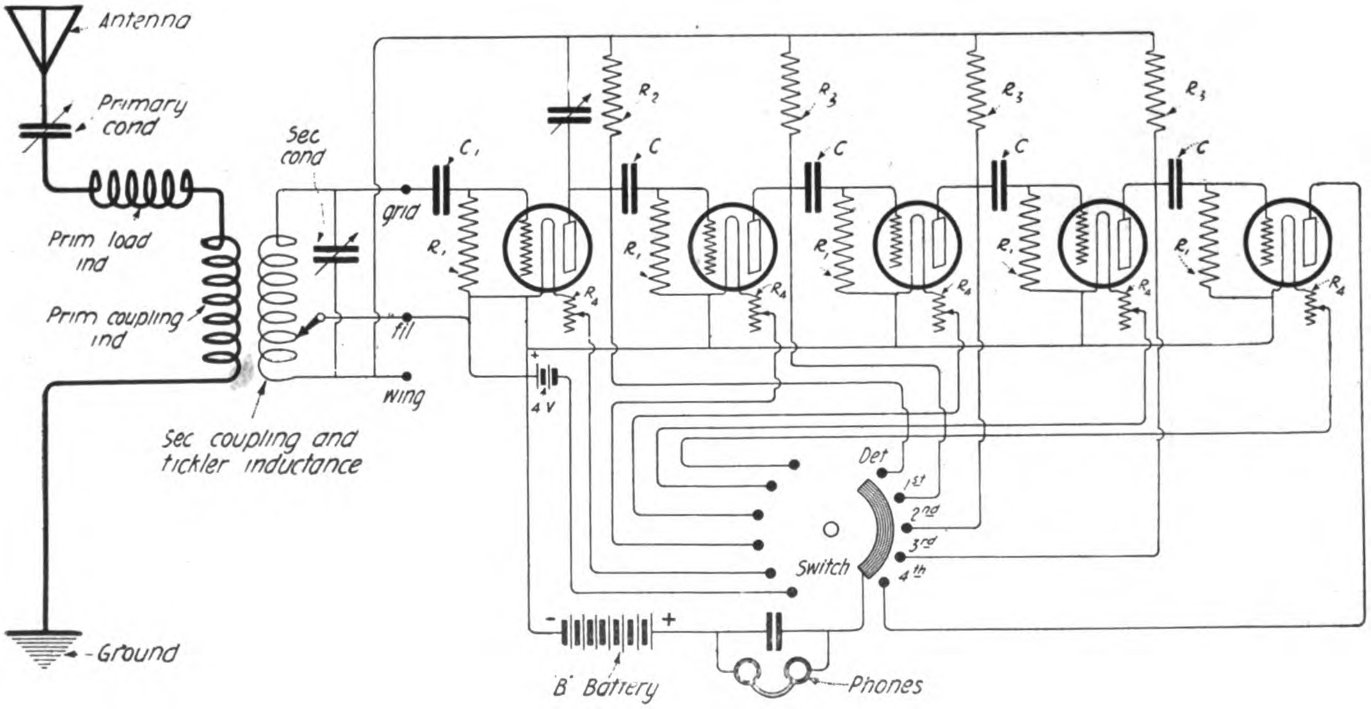


Figure 8—Schematic wiring diagram of V. T. detector and resistance coupled amplifier—four stages—with regenerative feature

A direct current meter is connected in the filament circuit, so that the V.T.'s may be adjusted to their proper filament temperature.

Binding posts are provided and each post has a lug underneath it so that if a permanent installation is desired the wires may be conveniently soldered.

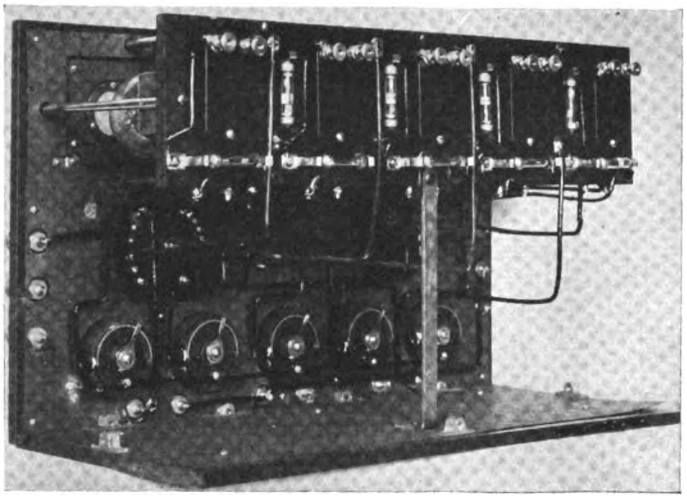


Figure 7—Showing the grid leaks in vertical and horizontal positions

A filament rheostat is provided for each V.T. The construction of this rheostat is shown in figure 5.

The complete rheostats may be purchased at a reasonable price from the Adams-Morgan Co.

In some vacuum tubes the grid and plate internal connections are not perfect electrically and it becomes necessary to provide a shock proof mounting to guard against noise being produced by vibration of the instrument. A successful design was worked out as shown in figure 6.

At the time of this design, moulded V.T. sockets and grid leak holders were not available, but can now be purchased of the Radio Corporation of America and used here to advantage.

In figure 7 the grid leaks shown in the vertical position are the output resistances, the one to the extreme right is R2 (500,000 ohm), the other three (R3) are two megohm resistances. The five horizontal resistances (R1) are all two megohm grid leaks.

The condensers (C1) are all .005 fixed condensers. The condenser (C2) should be a variable air condenser with a maximum capacity of approximately .0025 microfarads. This latter condenser, called the bridging condenser, allows the high frequency oscillations to pass around the resistance (R2).

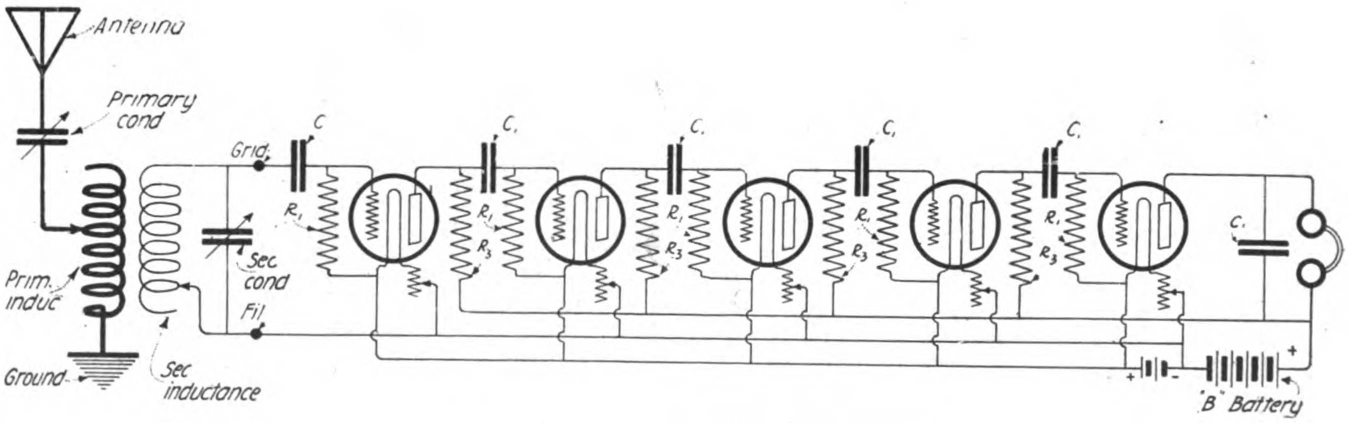


Figure 9—Diagram of five-stage resistance coupled amplifier without regenerative detector feature

The front panel is lined with a piece of soft drawn sheet copper .012 inch thick. Clearance holes are cut for the meter, window, binding post, rheostats and switch, as shown in the photographs. The front panel is fastened permanently to the base and the rest of the case, consisting of the top, back and two sides, in one piece, fits on and is screwed to small brass castings on the base. This case is also lined with copper and all joints should touch when the cover is on. The binding post is connected to the copper lining.

All connections are made with No. 12 hard drawn copper wire, covered with black Empire cloth tubing and joints are all soldered. Flexible leads from tube panel consist of 150 No. 40 bare copper wire in cotton sleeve.

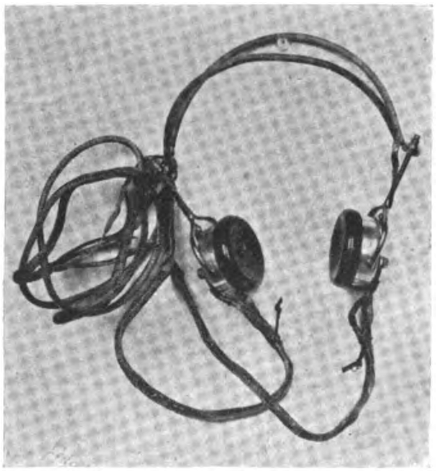


Figure 10—Shielded telephone head set with flexible Belden braid wire cord

In the schematic wiring diagram, figure 8, a regenerative circuit is shown. The switch controls the amount of inductance in the wing circuit, coupled directly or conductively to the secondary coupling coil. Regeneration of spark signals, or production of oscillations for heterodyne reception of undamped oscillation can be controlled with this switch.

In case the regenerative feature and control switches are to be eliminated for the sake of simplicity, another schematic diagram is given in figure 9.

A pair of shielded telephones are shown in figure 10. Flexible Belden braid is so woven that it can be made into a hollow flexible tube. A large size braid is slipped over the double part of the telephone cord and a smaller size slipped over the single parts of the cord. The joints are wrapped with fine soft copper wire. The headband is connected to this shield at top and a lead from this shield at the bottom is connected to the ground post of the amplifier.

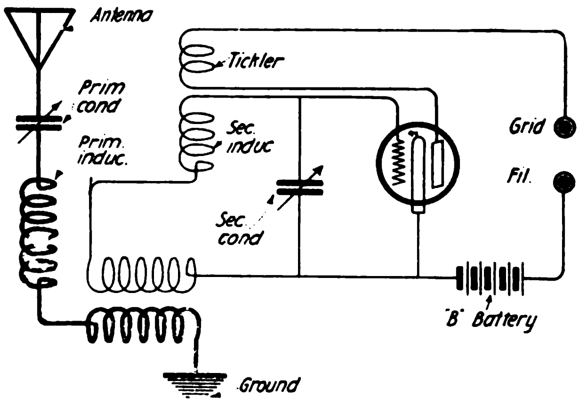


Figure 11—Regenerative receiver circuit which is connected to the plain five-stage amplifier circuit

The plain five-stage amplifier may be connected to a regenerative receiver as shown in the two following diagrams, figures 11 and 12.

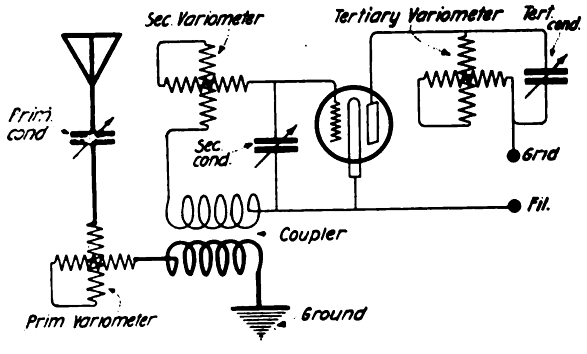


Figure 12—Another regenerative receiver circuit used in connection with the five-stage amplifier

For this purpose Marconi V.T. amplifier tubes should be used at a plate potential of 120 volts

Winding Inductances of Honeycomb Cross Section

By Everett L. Sweet

BELOW is a method whereby amateurs may wind inductances very similar to the honeycomb type of inductance now apparently so popular. No dimensions have been given, the size of wire, number of turns and diameter of coil being left to the amateur, as well as the number of layers.

The wire is wound on a wooden cylinder about ¾ inch thick and 2 to 2½ inches in diameter. On a circle concentric with the face of the cylinder and out ¼ inch from its edge, 12 holes are drilled. These holes are spaced equally around the circle. Figure 1 shows this cylinder with holes drilled. 24 lengths of number 12 or 14 wire 2 inches long are bent into a "U" shape. Care must be taken to have the sides of the "U" straight and parallel. These "U" shaped pieces of wire are clamped by machine screws on to the disc, one being placed under the head of the screw and one being held in place by the nut which threads on to the screw on the opposite side of the disc. Figure 2 shows the form with the wires assembled. The wooden cylinder and the "U" shaped wires now present the appearance of a hub with a double row of spokes and the form is ready to receive the wire.

Let the prongs on the face of the disc be designated by the numbers 1, 2, 3, etc. as in figure 2 and the corresponding prongs in the rear of the disc be numbered 1', 2', 3', etc. The wire is started by being hooked over prong 1 and then is wound ½ turn on the cylinder and passed outside of prong 13' and 13' only. The wire is passed around prongs 2 and 14', 3 and 15' 4 and 16', etc. in succession. Figure 3 shows the scheme of winding, the turns being numbered. It will be seen that when the wire is passed around all the prongs the wooden form will have been covered to a uniform thickness of two layers. When the first revolution has been completed the procedure is the same as in the beginning. Any number of layers may be wound on. To determine the number of turns wound on the form, one has only to multiply the number of double layers by the turns per double layer, in this case, 24. The prongs are drawn out when the winding is completed and one has remaining a self-supporting inductance of the honeycomb type on a wooden disc. If it is desired to remove the disc, two or three layers of paper should be wound on to the disc before the winding of the wire is started.

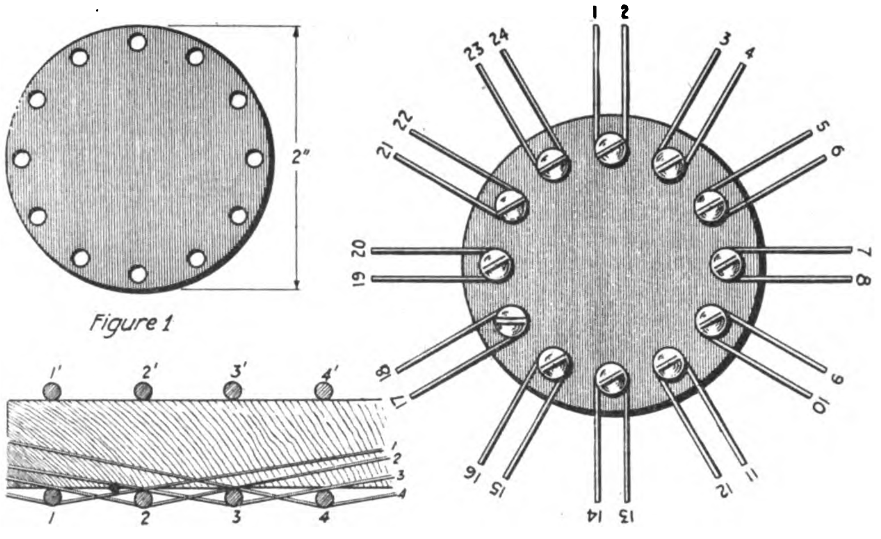


Figure 1

Figure 3

Figure 2

Constructional view of apparatus and method of winding honeycomb inductances

Receiver Circuit

By U. B. Ross

SEVERAL months ago I wrote concerning an improvement on the circuit described by Morton Sterns, which I had commenced experimenting with at the time. I am enclosing a hook-up similar, but with the addition of the variable capacitance C and a conventional one step amplifier.

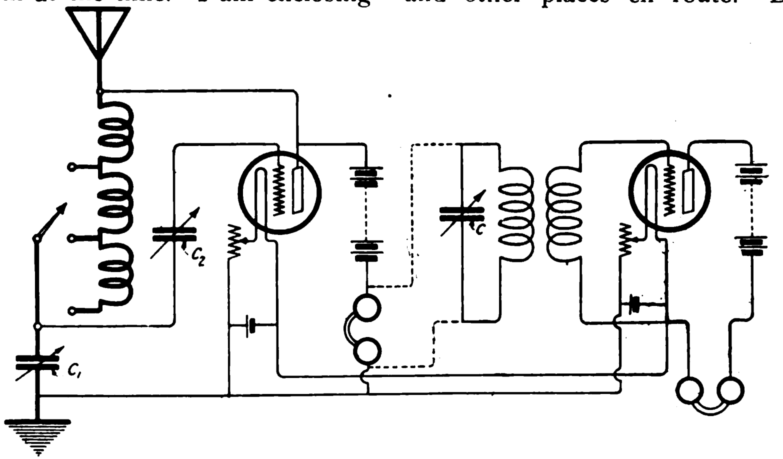


Figure 1—Circuit requiring simple adjustment to tune to various wave lengths

I am pleased to state after exhaustive trials aboardship that the above has come up to and exceeded my highest expectations. The tests cover a period of more than two months, six weeks of which were spent in the harbor of Port of Spain, Trinidad, and other places en route. During this time, practically all the high power C.W. stations in Europe and North America were copied. Among those heard were the following: MUU, POZ, LCM, BYC, NFF, LDO, NSS, UA, BZL, BZR, BZO, BZK, BZQ, BZM, NAT, NZR, NBA, also the spark stations: NAA, XDA, BZL, BZO, SPA, etc., as well as countless stations on lower wavelengths. These stations were easily read day and night through moderate static.

The circuit used possesses the merit of very simple adjustment throughout the whole range of wavelengths and a child could be taught to tune same in a few moments. Practically all the tuning is done with C1, C2 being rarely touched and C being used to adjust the pitch of the incoming signal to suit the ear of the operator, which is a great advantage during static.

I have found that the "B" battery potential should be slightly greater than usual to cause the set to oscillate on low wavelengths than on high waves, but this is doubtless due to the fact that I am not using the standard V.T.'s. I am certain that anyone who gives this circuit a fair trial will be highly enthusiastic over the results. I have had no opportunities of testing the above with more than one step of amplification.

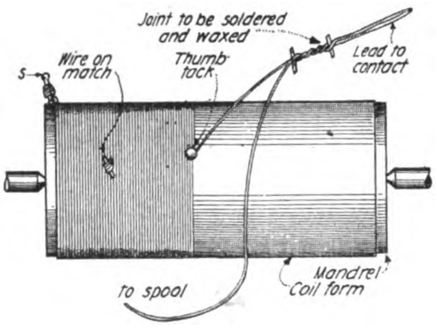
Winding and Tapping Radio Coils

By Leo M. Lafave

THIS will serve to describe a method of easily tapping large coils for radio work, a method which the writer has used to good advantage and believes to be more efficient than simply making a loop in the wire as is usually done.

The sketch illustrates a mandrel in a lathe and the coil form ready to wind the wire on. The wire is fastened at the starting point (S) and the lead wound on a piece of match, if small wire is used, to keep it out of the way. Thick shellac is applied for a short distance on the coil form at least up to the point where the first tap is to be made. It dries too quickly to put more on at a time.

When the wire has been wound up to the first tap, it is fastened with a thumb-take and a loop made as shown. Now, instead of merely twisting the wire together, the insulation is removed for a distance of one-half inch, the wire cleaned, powdered rosin applied and the twisted joint dipped in molten solder. When soldered good, it is transferred to molten wax. A good wax may be made of beeswax and rosin (1 part beeswax, 2 parts rosin). The loop of wire is then wound on a piece of wood so that it will not get tangled when winding on more wire.



Method of winding

It will be noticed that when the twisted joint of the tap is soldered the current does not have to pass through the lead wire of any tap when it is not in use. The joint cannot come loose and the shellac prevents the wire from loosening at variations of temperature. It is not advisable to shellac or varnish coils after they are wound.

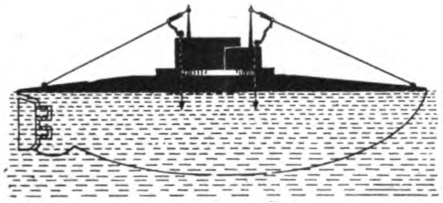
If the leads are to be carried through the inside of the coil form, small holes are made at the exact location of the joint and the leads passed through, numbering each one so it may be identified when wiring to the multiple switch. A hot knife will facilitate getting the soldered and waxed joint home and then once there it will stay. I do not claim this to be the only good method for this work and of course where dead-end switches are to be used the wires must remain insulated, but I have found it very useful and I am presenting it with the hope that others will appreciate its advantages, as any slight improvement in construction is worth while in radio work.

Loop Antenna for Submarines

By Ralph R. Batcher

THE subject of loop antenna has given considerable impetus during the past several years and a large number of articles have appeared of late in radio literature. Among these a few, such as the report of the lecture by J. H. Dellinger before the A. I. E. E. and I. R. E., an article by Captain Blatterman, published by Franklin Institute, give considerable information of value concerning the merits of this type of antenna.

A large amount of research work done by the Bureau of Standards extending over a period of nearly five years, has just been disclosed to the public. The work done and results obtained with submarine radio communication are of especial interest.



Submarine with loop antenna in place

To a person who has studied the principles of radio wave propagation through the ether, the statement that messages were transmitted and received while the submarine was running full speed submerged a few feet under the water, will appear unbelievable. He certainly becomes more interested with trying to evolve an explanation of the results than does the experimenter who considers the whole subject of radio transmission an unexplainable mystery, each new discovery only going to show the

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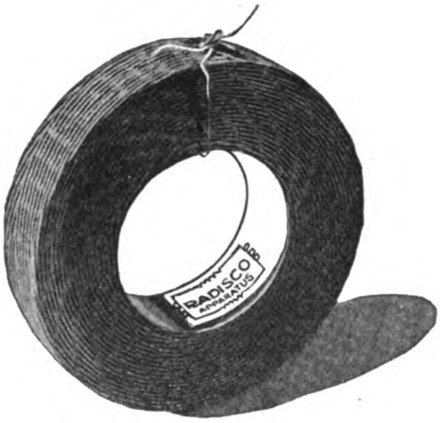

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BROOKLYN, N. Y.
Kelly & Phillips Electric Co.,
312 Flatbush Ave.

BRONX, NEW YORK CITY.
Amateur Wireless Equipment Co.,
1390 Prospect Ave.

CHICAGO, ILL.
Chicago Radio Laboratories,
1316 Carmen Ave.

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futility of trying to discover a reason.

The men who have been chief investigators on the submarine communication problem have been Mr. J. A. Willoughby and Mr. P. D. Lowell, of the Bureau of Standards. All of the work was carried out at the New London, Conn., submarine base. The experiments were complete in every detail and involved the construction of every type of aerial that was possible to erect on a submarine. The choice finally narrowed down to one type: a single turn loop consisting of two insulated wires running from the interior through two watertight insulators located at the center up to a short mast and then down to each end where the wires are firmly grounded to the hull.

Figure 1 shows the construction of such an antenna. It will be seen that the hull itself is included in the antenna system. The conductor used was a special rubber covered phosphor bronze wire selected to withstand the action of long exposure to salt water. It was necessary to protect the ends of the wire with a special sleeve to prevent the water rising up within the insulation by the capillary action between the strands. These sleeves were electrically connected to the conductor and served as the connecting link between the wires and the hull.

The connections from the set to the loop are made through two insulators running through the deck above the bridge. Care was taken so that the insulation was continuous over all exposed parts. A condenser of 0.005 mf. capacity was generally connected across the terminals of the loop.

It was found that the regular radio transmitting and receiving equipment could be used, the only difference being that the sets were very compact due to the limited space available for the equipment. The receiving apparatus was of the Navy Standard type with a range up to 16,000 meters. While it was found that the regular type of audion control box and two step amplifier of the Navy could be used, best results were obtained when these instruments were designed to be insensitive to mechanical vibration and induction effects. This was obtained by special bulb mountings and physical arrangements of the parts within these instruments. The transmitting set was of the quenched gap type and generally had 1 kw capacity.

As soon as submarine communication was under way, many interesting phenomena were observed. The fact that the maximum depth to which the antenna could be submerged without cutting off communication was dependent upon the wave length used was noticed at the beginning. To receive short waves, it is necessary that

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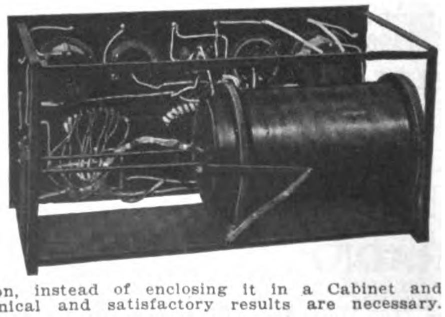

We reproduce the set in its entirety that you may see and understand its construction, instead of enclosing it in a Cabinet and allowing you to guess. It is now used in Schools of Radio instruction where Technical and satisfactory results are necessary.

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the antenna be near the surface, while reception of longer waves from 2,000 to 16,000 meters could be maintained at depths down to 21 feet below the surface.

Communication can be carried on between two submarines using the standard wavelength of 952 meters, a distance of 12 miles when the antenna of each was entirely submerged. It was found that the wavelength did not vary to any great extent if the submarine were to submerge while the set was being operated. This is a valuable detail since it insures the independence of the operation of the radio set and the control of the boat, the maneuvering of the latter causing no interruption of wireless service, unless the depth limit for the wave being used was exceeded.

When transmitting and receiving above the surface, the distances obtainable compare very favorably with installations on other boats that have a much higher antenna available. The directive effect of the loop proved of great value in a great many instances both in the determination of the location of transmitting stations and in the cutting down of the signal strength in certain directions when secrecy was desired or to lessen interference.

Dependable distances for reception are shown by the following items taken from the log of a boat using this type of antenna.

NAA—100 kw. undamped, heard 200 miles at a depth of 16 feet.

NFF—150 kw. undamped, heard 100 miles at a depth of 21 feet.

NWW—150 kw. undamped, heard 100 miles at a depth of 21 feet.

NPL—250 kw. undamped, heard 3,000 miles at depth of 8 feet.

POZ—Heard 6,000 miles at a depth of 8 feet.

NAA—100 kw. spark, heard 200 miles at a depth of 8 feet.

Transmitting results using the standard wavelength of 952 meters are shown by the following items from a log. The total distance in each case at which signals would have been readable were estimated at from two to four times the actual distances given below. The antenna current was 12 amperes on the surface and 6 amperes when submerged.

Test No. 1—Submarine submerged running full speed with loop near surface. Actual distance transmitted 12 miles.

Test No. 2—Running full speed with top of loop slightly submerged, 9 miles.

Test No. 3—Top of loop submerged 9 feet. Messages sent 3 miles.

The value to a submarine of a device like this that provides ears when submerged, and even eyes to locate transmitting sets, can hardly be estimated. Often the radio equipment is needed the most when for secrecy it must be kept submerged so that the perfection of this type of installation fills a vital need.

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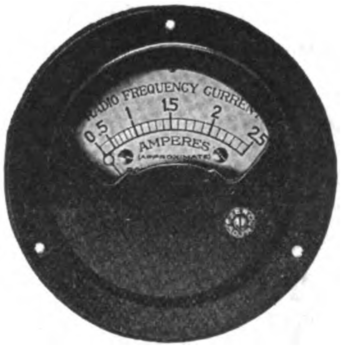

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L-50	240-730	1.52	LL50	1.64
L-75	330-1030	1.60	LL75	1.70
L-100	450-1460	1.70	LL100	1.76
L-150	660-2200	1.80	LL150	2.16
L-200	860-2850	1.90	LL200	2.28
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The Effect of Wireless Waves on Fruit Trees

By Wingfield Howe

At the home in Los Angeles of Seefred Brothers, known through their activities in the amateur radio field, is a peach tree that has a history in connection with this subject.

It was only a seedling and might never have received notice had it not been for the benefit it derived from wireless. It came from a chance seed in 1896 and was transplanted the following year to its present position to help beautify a new home, perhaps with blossoms or simply as a green tree. Later it became a matter of surprise if it did not bear from one to three peaches.

A tree of this kind that bears is not supposed to live more than four or five years, but as this one had no fruit to speak of it continued to thrive and was allowed to remain as a nicely shaped tree.

Then the boys began to experiment with wireless and the tree had a continual renewal of youth from the wireless waves, it being near the station and nearly under the aerial. As they became more interested in their work the tree increased in bearing until, in the spring of 1916, it bloomed so profusely it was thought best to relieve the tree by cutting out several large branches. As the fruit set on heavily and was filling out very fast, it was thinned so as to leave but one peach to a twig.

During this time there was much long-distance work done on high power late at night and it would seem to be the reason for there being 120 large and juicy yellow freestone peaches of fine flavor that were the wonder of all who saw them. The fruit averaged half a pound each and some a few ounces over—as big as coffee cups.

Then came the war in 1917 and cessation of transmitting, when most of the fruit dried on the seeds or dropped off. That remaining filled out a little next the sun, while the under side was hard and dry. It made about two quarts of inferior fruit.

In 1918 there was still no vitalizing influence in the air and the leaves began to wither as soon as they appeared. As the tree had shown its worth it was cut back close, the ends painted and carefully tended. It managed to survive and, generally put forth new growth, but no fruit.

During the present year, 1919, two

Prize Contest Announcement

The delay in publication of the November and December issues of the Wireless Age, resulting from the printers' strike, has made it impossible for contestants to submit contributions for the Prize Contests announced in these two issues within the time limits specified.

So an extension of time will be allowed. The closing dates for the contests announced in the November and December issues have been advanced to February 29th, in both cases. The two subjects which are thus given a new lease of life are:

"Design and Construction of a Low Power Transmitter for Local Use"

"An Original Design for an Antenna Switch"

Contestants for prizes to be awarded with the publication of the March issue are requested to submit articles on

"Mast Construction for the Average Amateur"

Closing Date February 14th

"If wishes were horses, beggars might ride," and if wishes were nice, slim, upstanding, non-skid and all-weather 75-foot radio masts, a lot of us would stand a great deal more chance of talking to the Chew Sing Chews with our BC 2s.

Not until a final and complete list of all amateurs is available will we have a completed list of those who have lifted themselves by the seat of the pants through the 2' x 2' window in the back attic at 1 A. M. while the folks peacefully slept below, but to sit on the peak of the roof and gaze in ecstasy at the top of a beautiful, slender, self-supporting and (alas!) imaginary mast.

Some of us lost our mast-fever and came down with chills. Others of us found splinters when we went to "lift," but we had ideas—ideas which the Wireless Age hopes to hear about.

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dozen peaches appeared, but, remaining hard and rather small, were not considered worth bothering with. The fruit being of a late kind hung on for several weeks after the ban against transmitting was removed, and one day it was noticed two had ripened and fallen and all had grown large and mellow. They were at once canned—four quarts of delicious fruit. But the odd part was that in each peach the print of the seed space had grown beyond about half an inch in filling out, seemingly *stretching* forward with the sudden growth caused by wireless waves.

The same beneficial effects have been noticed on other trees. It is just possible that radio waves may be utilized to secure increased productivity in the orchard in the near future, thus adding to the pleasure experienced by our younger men in radio communication.

Concerning the Audion

By Wm. D. McPherson

SERIOUS consideration given to an article in a contemporary magazine would cause one to believe that the crystal detector is practically sufficient in its good results to warrant its use in a modern amateur station. In my opinion, such thought is seriously hampering the art of successful long-distance amateur radio work. To the amateur of some years' experience, no argument or discussion is necessary to bring him to a belief in the superiority of the audion over the crystal. However, the one who is in doubt as to whether an audion will justify its cost will be influenced a great deal by reading that "for steady amateur work, long usage, moderately long distance work, ease of adjustment and low cost of upkeep, the crystal detector is the thing." Now to read that, a layman might construe that an audion costs a fortune, and costs a fortune in upkeep, and moreover necessitates a great complexity of adjustment. None of these features obtain, when you consider that one can get a V.T. for $7.00; and that is the nucleus of the whole thing. Ten cent flashlight batteries make a very good source of plate potential, and for filament current supply a second-hand 6-volt storage battery is amply sufficient. It need not be a first class storage battery. Now where is the conscientious, serious amateur who will not compel himself to afford these? If his heart is in it at all, he will find a means of obtaining these things. If he does not care enough to want these he does not deserve to belong to the fraternity.

Seriously, I am of the opinion that no amateur should be permitted to operate a transmitting set of any description whatever, without first possessing a receiver equal to a single bulb regenerative set. We have all seen amateurs who actually could send further than they were capable of receiving on the equipment they had. There, my friends, is the cause of 90 per cent of all unnecessary QRM—amateurs with poor receiving equipment who could not even hear the fellows they were busting up. For instance, here we have an amateur with a fair antenna of average dimensions. He has a good transmitting set upon which he has evidently concentrated most of his energies. Now, for receiving, what does he use? He uses galena (which makes a very pretty paperweight, if you can get a large enough piece) instead of an audion. He comes on the job at 6.30 in the evening when the weather is nice and cool and crisp. He "listens in" as the regulations require he shall do, and hearing no one working, opens up and lets go a big long CQ. When he finishes 8-- comes right back and asks him please QRX as he (8--) is working with 2---. Now if the original man we are talking about were using an audion, he would have heard 2--- working with 8--, and would have kept still long enough to know what was what. He would not have been so anxious to tear up the air, for he would have had something worth

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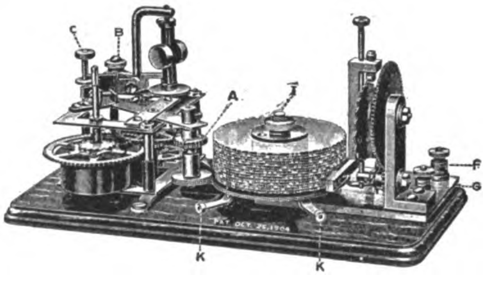

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while listening to, and the chances are he would have listened. There once was a "guy" in our town who was a typical example of the above. Happily he is now gone. I have heard him come on in the afternoon when he got home from school, and send a big long CQ. When he got through some fellow in the 9th District would be calling him anxiously. Did he hear him? He did not! Would any one bother to tell him that 9-- was answering him? No, they would not, for a fellow who would tear up the air for 500 miles around and not be able to take care of himself when it came to receiving that distance, does not deserve the assistance of his brothers. He is responsible for the jamming that is caused. And by the way, when a long distance relay is being attempted, who is it that bothers? It is not the amateurs around you within a hundred miles; it is the fellow a long distance away who "freaks in" and does not know he is bothering. Therefore, it behooves every amateur who considers himself worthy of the name to make every effort to own the best receiving equipment possible.

Speaking of this matter of listening, one will find that the best and most liked amateurs are those who have sets on which they hear everything, and what is more those who do hear everything do not spout a stream of sparks every chance they get. You will find they do a lot of listening—they will be listening when you would never suspect it. They do not consider time spent listening as lost. They might be on for six hours, or six days, and you would not hear a peep out of them. Why? Because they had real sets to listen on and always heard something. Now, take the other side. Who was causing that jumble of sparks, that jargon of 200-meter stuff through which you could not get an intelligible word? It was a bunch of amateurs who used crystal detectors and who considered themselves lucky to work anybody a hundred miles off. You see they could not fill the air full enough, with the small capacity they had, to give themselves any satisfaction, for it was well nigh impossible to talk to some one they couldn't hear —sometimes it is done with the assistance of a third party. Maybe if this type of amateur had to be satisfied with the privilege of receiving he would learn to listen, and not jump over the traces.

Just a word about the use of amplifiers. There is nothing against applying the regenerative feature to the amplifier. Of course, the idea is not new, but some experimenters do not seem to take note of the fact that what a tickler circuit will do for a single bulb it will do many times over for a circuit in which there is an amplifier. The feedback coil should be placed in the same part of the plate circuit as when one has only a single tube in operation. Some time ago there was considerable discussion as to which the amateur could better afford, a regenerative receiver or a cascade amplifier. There need be no question about it, for a regenerative receiver plus an amplifier circuit is better than either, and will bring in signals that could not be heard otherwise.

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The Wireless Amateurs of Albany, N. Y., which number between fifty and sixty have revived interest in the Albany Radio Club, which hold their meetings on the first and third Tuesday evenings of each month.

At a recent meeting the following officers were elected: President, E. C. Fasoldt; Vice-President, W. Stein; Secretary-Treasurer, K. B. Hoffman.

Plans have been made for the erection of the former radio equipment on the roof of the Y. M. C. A. building. Also lectures will be given on various Radio subjects by prominent Radio men.

Other clubs are invited to communicate with us. Address all communications to Karl B. Hoffman, Secretary, Albany Radio Club, 5 Summit Ave., Albany, N. Y.

The regular monthly meeting of the Radio Club of Hartford was held on January 13th at the rooms of the Automobile Club of Hartford. President Walter B. Spencer presided. The speaker of the evening was Mr. Hiram Percy Maxim, one of Hartford's most prominent radio amateurs. Mr. Maxim spoke on "Aerials," describing how he built his two eighty-foot masts and how his seventeen-wire semi-fan shaped aerial was constructed. Using this aerial and a little over three-quarters of a kilowatt of power, Mr. Maxim has been heard in Chicago and New Orleans, so Mr. Maxim is considered something of an authority on aerials.

The subject of "Kick-backs" was also discussed, many of the members of the Club having experienced this trouble at one time or another during their radio careers. Mr. Thomson and Mr. Soper, of the Hartford Electric Light Company, were present, and Mr. Thomson spoke on "Co-operation between the Radio Amateur and the Electric Light Company."

It was voted to supply the Hartford Electric Light Company with all available data respecting radio stations within the territory covered by the Company's wires.

No date was set for the next meet-

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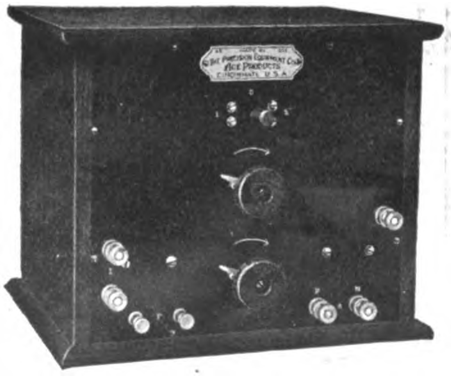

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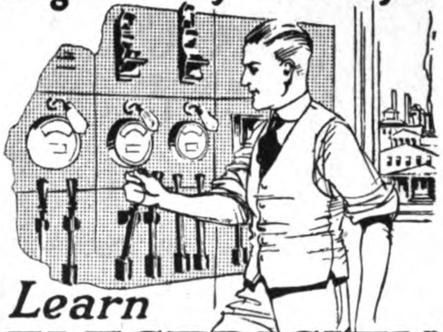

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ing, the secretary being instructed to send out notices when a date was decided upon.

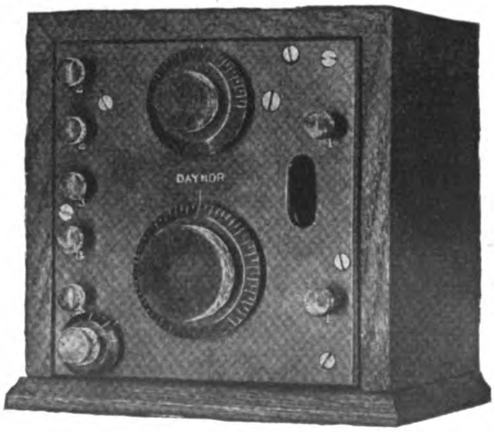
We heartily approve of the idea of devoting a section of The Wireless Age to news of the activities of the various radio clubs. We like to know what other radio clubs are doing in other parts of the country. We think the Radio Club section of your magazine is sure to be a big success.

Do It Yourself

By S. F. McCartney

One of the most admirable characteristics of the radio amateur is his desire to do things and make things himself—not merely to save money, though that is proper and desirable, but for the joy of accomplishment—art for art's sake. It is well that the inclination of the amateur runs in this direction, especially in this era of price madness. Very often one can make repairs practically as well as the so-called expert, or perhaps I should say as well as some so-called experts. I fear that a tendency actually exists to make the cost of repairs and parts almost prohibitive—and this at a time when the supply of manufactured goods is alleged to be unequal to the demand. In a recent instance a distributing agent wrote a retail dealer who had ordered some replacement parts for a patron that he "ought to discourage such business." In this state of things the amateur should exercise his ingenuity to the utmost.

The present writer does not recall reading anything from the amateur on the subject of repairing a portable storage battery. Yet this can sometimes be done, and at slight cost, where a service station would charge half or three-fourths the price of a new battery. I have had a little experience that may be of some interest and value to the operator who uses a storage battery. A few years ago I purchased a low-priced storage battery. It gave first-class service until some months ago, when I had the misfortune to take it to a person for charging who had some ideas on batteries not embodied in the textbooks. His plan for bringing up the specific gravity of the electrolyte was to add more acid. I explained to him that I thought he was quite right, but that I should rather have the acid then in the plates driven back into the electrolyte and by application of an electric current. He seemed to regard this idea as a dangerous heresy, and rather resented the proffer of the information. I later took the battery to another charging station. Here it was pronounced short-circuited. I asked whether there was any remedy. "Yes," said the manager, "we can tear it down and rebuild it." He further stated that the charge for this work would be $8.00. The battery originally cost $11.00. "And just what repairs would you make?" I asked. He said they would put in new separators and new acid. "And the cost would be eight dollars!" I cried. "Yes, that's it." "Well," I remarked, "that would be a prohibitive charge." And indeed it was prohibitive; for the plates, even with new separators, might have lasted only a short time. So I carried the battery back home. I knew something of the theory and use of the storage battery, but had never had any experience with the internal parts; so I concluded that now was the time to learn, especially as my battery was useless in its present state. Stated in a few words, I tore the battery down, removed the sediment from the cells and washed the plates and put in sixty cents worth of new separators. I then took the



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battery back to the same charging station. It took the charge in a satisfactory manner and has been carrying on "business as usual" since—saving, $7.40.

Some information, based on my experience, as to repairing a battery that has "died" might prove useful to the amateur.

Empty the acid into a glass or earthenware vessel. Rinse the cells out with fresh water, so the matter that will afterwards get on your hands will not be so injurious to the skin. Then set the battery in a warm place for several hours in order to soften the sealing compound over the top. You will need a tool something like an old table knife that has been broken in two in the middle and sharpened on the end, and possibly an old file to use as a bar. When the sealing compound is soft enough, remove it with the knife. If necessary, pour a stream of boiling water over it to make it softer. When the covering has been loosened turn the battery over on its side. Place a piece of board the thickness of the wall of the battery on the table for the plates to rest on as they are pulled out. Then take the little bar and start the plates outward. Proceed carefully because the hard rubber cells and covers are brittle. All the plates in each cell must come out at the same time as they are fastened together with heavy connectors. These connectors, however, are lead and will stand some bending without injury. When the plates are out the internal parts of the battery should be thoroughly examined. Empty the sediment from the cells, because if it is high enough it could cause a short-circuit. If the plates are found to be intact and the positive one a chocolate color with the negative one a lead color, it may be assumed that they are in fairly good condition, and that the trouble is in the separators. Since the plates in a portable storage battery are very close together, a small crack in a separator will cause a short-circuit. All the separators should now be removed. The battery being open, the separators (costing only five cents each) should all be replaced whether they look bad or not. When this has been done the plates may be shoved back into the cells and covered with the same old acid. The battery is now ready to go to the charging station. If it performs as is expected, the top should afterwards be sealed over with the compound that was removed. Some should be heated to a plastic state and the covers cemented to the tops of the rubber jars. When this paste has hardened the balance of the compound may be heated so it will run and poured over the entire top of the battery as was originally done.

In taking down batteries one will doubtless be puzzled at times to know whether a particular set of plates is of any further use. If they are badly decayed and broken down or coated with a white deposit, their further utility is doubtful. However, it would be interesting to ascertain just how they would perform under charge. The cost of the necessary separators is slight, so if the experimenter's time is not too valuable, he may as well proceed until the battery's exact condition is known. One might get several months more service from them; if not, the pecuniary loss is slight.

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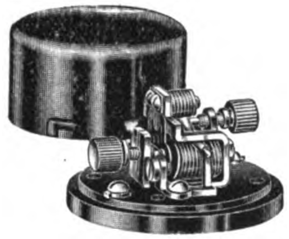

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G. L. H., Rome, Georgia:

The form which you show, 3½" in diameter and 1¼" thick with two slots ¼" deep by ⅜" wide and separated ¼", will serve you very well for a loading inductance form to be used with a short wave regenerative receiver, if you must use a coil of this type. Wind it with No. 27 double silk covered wire and take off taps every 15 turns or so. The secondary should be tuned with a condenser in shunt from grid lead of the receiver to filament lead. In general, however, unsatisfactory results are obtained when it is attempted to load a receiver—particularly designed for short wavelengths to longer wavelengths. It would be best for you to provide yourself with long wave inductances and condensers.

* * *

F. D. G., Woodlawn, L. I.:

An antenna composed of 6 wires 80 ft. long and 35 ft. high would have a fundamental of approximately 153 meters. Inasmuch as you do not state the length of your lead-in, nor the height of the antenna, we assume that a ground wire, length 35 ft., includes this. Separating the wires 2 ft. instead of 6" would only slightly increase the fundamental. Using a variable capacity of .001 in shunt to your receiver secondary, the range of your closed circuit is up to about 2500 meters. Your primary circuit, in all probability, will not go much over 1800 meters.

* * *

W. T., Fountain City, Texas:

In general a tickler coil having about ⅓ the maximum number of turns of wire as used on the secondary coil of the receiver is suitable when the mechanical dimensions of the two coils are of the same order.

With reference to the high voltage battery described in the February issue, the Plante method of construction will give you very fair results if it is impossible for you to obtain the proper paste.

Regarding the wavemeter described in "How to Conduct a Radio Club," it will be all right for you to substitute a thoroughly dried and varnished paper tube instead of a hard rubber tube, without materially changing the constants of the coils, providing the tubes are of the same diameter.

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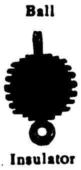

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* * *

C. R., Arlington, Mass.:

With reference to the loose coupler on pages 92 and 93 of "How to Conduct a Radio Club," the dimension for the primary as given in the text is correct. It should be 4" instead of 5" in the drawing.

* * *

G. D., Nicolet, P. Q.:

At the present time, messages are being received in America from France by the Naval receiving stations at Bar Harbor, Me., and Washington, D. C. Lyons, France (call YN) is transmitting station and uses both a Poulsen arc and a LaTour alternator. He works on a wavelength of approximately 16,900 meters nearly every day between the hours of 9 and 2 P. M.

We regret that we have no data available regarding the Eiffel Tower station, "FL."

* * *

A. R. D., Readville, Va.:

The radio station at New Brunswick, N. J., uses a wavelength of 13,600 meters and is owned by the Radio Corporation of America. As far as we know, radio telephone experiments are no longer being carried on.

* * *

C. R., Valdosta, Ga.:

The diagram which you show for the arc is schematically correct. As far as we know, however, successful operation of an arc transmitter on amateur wavelengths has never been effected.

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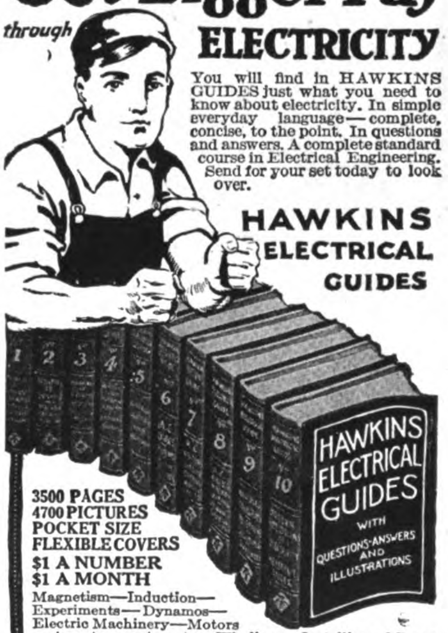
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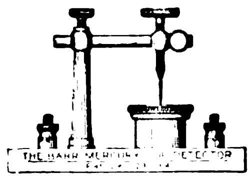

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Instantly adjustable at a constant pressure.

The Barr Mercury-Cup Detector Dept. D, The Wyoming, Washington, D. C.

Undamped waves can be received in the U. S. with one audion and loose coupler, loading coils, etc. We suggest you refer to "Practical Wireless Telegraphy" and "How to Conduct a Radio Club" by E. E. Bucher, Wireless Press, N. Y. C.

E. B. H., Belleville, Ill.:
Radio station VBE is situated at Point Edward, Canada.

* * *

A. H. R., Washington, D. C.:
The receiver described in the September prize article is in all probability the best amateur design, both from the mechanical and electrical point of view, which has been published. This set is capable of receiving trans-oceanic signals on a single vacuum tube. A set with practically the same electrical dimensions has been in operation over a long period of time. The diagram as printed is correct. The filament lighting battery is of course necessary and is inserted in the usual way.

* * *

R. C. A., Long Beach, Calif.:
We are inclined to believe that your lack of success with the one stage audio frequency amplifier is in all probability due to the choice of a poor amplifier transformer. When a regenerative circuit is used, one stage of radio frequency amplification would scarcely increase your signal strength, whereas one stage of radio frequency amplification of proper design should show a marked increase in signal strength.

* * *

A. W., Glenn Springs, Texas.:
With reference to the sketch which you enclose, we have no record of the better amateur stations ever having had satisfaction with an oil condenser. We suggest that you stick to the glass plate type immersed in oil. See Prize Articles in December issue.

* * *

G. W. G., Lebanon, Ill.
An antenna 40 ft. high and 40 ft. long is sufficiently large to enable you to receive time signals from the station of the Illinois Watch Co.
See answer to J. R. M., this issue.

* * *

H. P. M., Royse City, Texas:
We regret our inability to diagnose your troubles with the ultraudion or the peculiar action which you describe without a diagram of the connections which you have made.

* * *

W. G., New York City:
The radiophone described in the March issue is operative in every respect. A letter addressed to the author, in care of the Wireless Age will reach him. Your hot wire ammeter probably has such a range that the small currents which the outfit above mentioned supplies, will not register. Apparently you have for a moment forgotten your knowledge of the fundamental principles of radio. It is not to be expected that the connection of a pair of telephones to a radio frequency source will lead to any response in the telephones. We suggest that you persevere with your experiments, and provide yourself, if possible, with a hot wire ammeter having a range of 0-0.1 amperes inasmuch as the radiation to be expected from this outfit is of a small order. If no ammeter is available a 1 volt battery lamp of low candle power may be used instead, this being connected directly into the ground lead.

* * *

K. H. T., Newark, N. J.
(1) Sufficient reliable information has been printed in the columns of Wireless Age within the last few months to enable you to build for yourself an efficient short wave receiver.
(2) A .0006 mf. condenser will serve instead of the .0007 condenser when used in connection with the radiophone described in the October issue. If you desire to obtain a .0007 condenser, it may be had of the General Radio Co.

Your Wireless Outfit

Have you kept pace with the times?

Are you still operating the old style non-sensitive, poorly designed receiving apparatus? Or are you equipped with one of the new complete Gilbert Radio Outfits designed by an expert who was a Radio Officer in the U. S. Army during the war and who has incorporated all of the latest Army improvements in these new outfits.
Gilbert Radio Outfits are complete in every respect for transmitting, receiving, or both. They are without doubt the latest and most scientific outfits. Each piece of apparatus is designed to operate in close harmony with every other part of the set.

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A complete radio receiving set composed of Loose Coupler, Radiotector, Telephone Receivers. Insulators and Ground Wires. It will receive messages over a distance of 300 miles under average conditions and tunes sending stations whose wave lengths are from 200 to 2,500 meters. It is a very complete outfit for the advanced wireless operator. Loose Coupler set up in polished hardwood cabinet. Set includes complete book of instructions. Packed in corrugated container. Price, $25.00 (Canada, $37.50.)

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Price $13.00

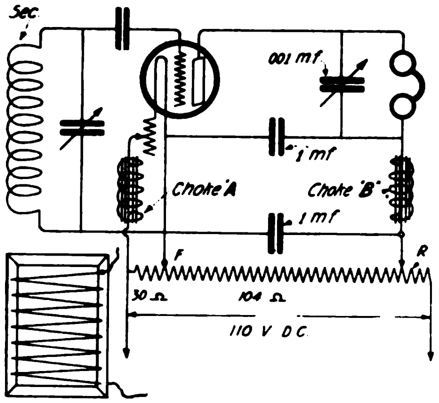
These head receivers are the exact type used by the Army and Navy wireless operators during the war.
The Signal Corps U. S. A. knew them as #P-11.
The U. S. Navy knew them as C-W 834.

JAMES O. OLIVER & COMPANY
20 Nassau Street New York City

M. D. F., Woodfords, Me.:

A tickler coil is always placed in series with the plate circuit and is coupled with the secondary or closed oscillatory inductance. We publish a diagram herewith which will enable you to connect your receiver tubes onto the 110 volt D. C. line. When the generator is running you may experience some trouble due to commutator noises. This will be eliminated to some extent by the use of the filter circuit shown.

For resistance R 730 feet No. 20 German silver wire is wound on a rack as shown. Tap F is taken off 165 feet from start. Other taps may be taken off if desired for plate circuit. Choke A may be 120 turns No. 18 D. C. C. wound on an iron core ¾" in diameter by 3½" long. For construction of B see answer to E. S. R.



W. H., Inglewood, Calif.:

(1) It is generally the practice in the better amateur stations to use a single receiver attached to a large horn for loud speaking purposes. Best results are had either with a receiver of the Baldwin type or a receiver of the type manufactured by the Western Electric Co. for the Signal Corps. When supplied from the output circuit of a two stage amplifier, such an arrangement usually gives all the volume necessary for reception without the use of receivers on the head.

This amplification may, of course, be carried further by mechanically connecting a microphone unit such as a Skinderviken button to the diaphragm of a receiver.

(2) We regret that space will not permit us to print the formula for the inductance of a layer wound solenoid in these columns. Such a formula is to be found in that of Rosa, Bulletin of the Bureau of Standards, Volume VIII, 1912.

We have arranged to have the calculation of layer wound inductances covered by an article which we hope to print in an early issue.

(3) The inductance of a coil of 126 turns of No. 24 double cotton covered wire wound in 3 layers on a form whose radius is 6.35 centimeters, each layer having a length of 3.81 centimeters, is 655,000 cms.

* * *

J. I. L., Coatesville, Pa.

The circuit which you have sent us is scarcely suitable for work below about 2,500 meters, due to unnecessary difficulty encountered in its manipulation. You will find in the columns of the WIRELESS AGE suggestions and information concerning the construction of receivers suitable for shorter wavelengths which should enable you to choose what you want for this work.

The dimensions of suitable coils and condensers for long wave work with this circuit are as follows: L1, L3, and L8, 6" in diameter by 24" long, wound with No. 28 single silk covered, taps taken off every 2". Coils L2, L4, L5, L7, L9, L10, are 6" in diameter, 6" long, No. 28 single silk covered, no taps. L6, L11, are 6" in diameter and 12" long, wound with No. 28 single silk covered, taps taken off every

Do You Want Efficiency?

Of course you do. But are you getting the utmost efficiency from your receiver? You will if you install the

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GREBE RADIO

Vacuum-Tube Detector and Two-Stage Audio-Frequency Amplifier

It embodies the latest development in Amplifier construction—The Grebe Automatic Control. A telephone jack and plug system controls both the filament and telephone circuits automatically. With the plug in the first jack the Detector only is in use; in the second jack one stage of amplification is added and the output transferred to the telephones. In the third jack the second stage is connected into circuit and the complete unit is in operation.

Amplifier tubes work best at a different B potential than detector tubes. The RORD Amplifier is equipped with two sets of binding posts for B batteries—one for the Detector the other for the Amplifier tubes.

You will get results from this Amplifier that will surprise you.

Send for free bulletin R-110; complete catalog 10 cents.

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"R.W.4" Size 12"x9"x6½"

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This unit has a normal output of 100 watts (200 milliamperes at 500 volts) with a voltage range of 200 to 500 volts. The generator is compounded to insure constant voltage under variable load. It is furnished to operate on either D. C. or A.C.; a shunt motor being supplied for D.C. and an induction motor for A. C. The generator is equipped with a commutator of 48 segments, reducing the commutator hum to a minimum.

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SHIPPING WEIGHT 80 LBS.

Unit is complete with insulating coupling and mounted as illustrated on a finished base 8" x 20". Shipment can be made immediately.

The motor generator illustrated above is only ONE of the many newly designed radio specialtie which we have ready for you. Write us for description bulletins which are being issued covering al International Radio products. Address Dept. No. 24.

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Designed for relay work on short waves. Marked coils only, waxed in box for panel mounting $10. Either of above tuners $15. Agents and dealers wanted. Catalog free.

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2 and 3 phase, A.C., 220 v, 60 c. 1750 RPM., complete with base and pulley.

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inch. C1, C2, C3, C4, C5, are each .001 mf. C6 should be about .0025, C7 about .0002 mf.

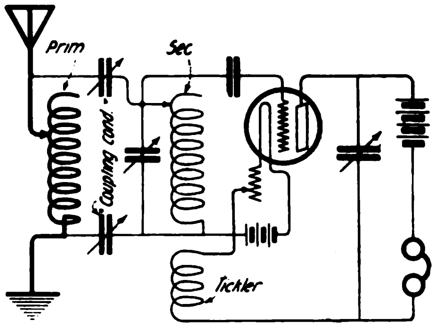
* * *

A. A., New Orleans, La.:

Below is a capacity coupled regenerative receiver and one stage amplifier. It is impossible for us to design a tickler coil for you without knowing something as to the design and wavelength range of your receiver. See answer to W. T. this issue.

Using a primary and a secondary each of three layers of single silk covered No. 28 wire, bank wound on tubes 12" x 4½" in conjunction with a .001 mf. condenser, the maximum wavelength obtainable will be about 20,000 meters.

Difficulty in the construction of such coils is usually encountered when the smaller sizes of wire are used, particularly if the wire be a solid one. The ratio of resistance to inductance in a bank-wound coil is lower than in a single layer coil of the same electrical dimensions, and, generally in connection with long wave work, are to be preferred due to the smaller space required and due to the fact that the increased distributed capacity at these wavelengths is not objectionable as it might be when encountered in conjunction with 200 meter work.



* * *

E. S. R., Toronto, Canada.

Part of the commutator noises with which you are troubled will be hard to eliminate if your machine is running at such a speed that the brushes spark. Normally, however, if you will shunt your generator line with a 1 mf. condenser and place in series with one side of the line a 6 henry coil, the ripple will have been sufficiently reduced for all practical purposes, when dealing with transmitter circuits. If you wish to make a coil of this sort, build up two iron cores of transformer iron, the pieces to be cut ⅝" wide and 2" long and piled up until a core has been formed ⅝" x ⅝", the pieces having been overlapped in such a way that when completed the core is 2½" in length, and when looking at the end of the core, every other piece appears to have been shortened by ½". On each of these, place a tight fitting head of fibre, 1⅝" x 1⅝" x ⅛" and space them ½" from the center of your core. After insulating the core, fill the spaces between the heads with No. 32 double silk covered copper wire. The two cores are now to be connected by slipping pieces of transformer iron into the slots in the ends. These last mentioned pieces will need to be ½" wide by 2⅞" in length. The two coils of this closed core inductance are then connected in series so that their fields are aiding.

It is possible to rewind a 500 volt generator so that it will give 1,500 volts. The output will be decreased somewhat.

Circuits have already been published in previous issues which will enable you to hook-up your four vacuum tubes for a resistance coupled amplifier. The fact that the filaments may draw different currents may be overcome by the use of a separate rheostat for each filament.

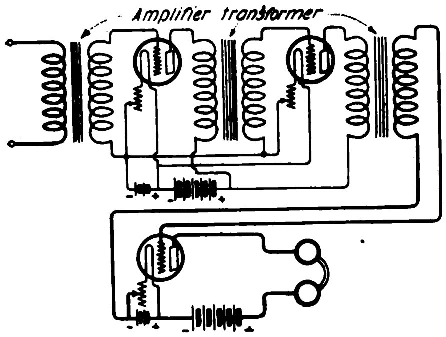
G. N. G., East Orange, N. J.

Most of the amateurs who are receiving radio telephone messages would make it hard for you to convince them that their hook-ups were not "really practical and efficient." We presume what you are looking for is something in the nature of a uni-control receiver. The nearest approach to this of which we know, that will fill your requirements, is that circuit given by Mr. Sterns in a recent issue.

* * *

M. R., San Francisco, Calif.:

Diagram of a three step amplifier is shown herewith, wherein tubes 1 and 2 and tube 3 are operated respectively by different batteries. An article on "How to Construct an Amplifier Transformer" will, we hope, be published in an early issue. Vacuum tube detector suitable for the undamped wave receiver shown on page 280 of "Practical Wireless Telegraphy" may be purchased of the Radio Corp. of America, N. Y. C. With reference to the receiving circuit which you mention, the coils should be tapped as follows: L15, + L2, 10 taps; L3, 15 taps; L4, 15 taps; L5, none; L6, none; L7, 15.



J. R. M., Philadelphia.

We hope to be able to publish at an early date, an article on "How to Construct an Amplifier Transformer." This subject is too lengthy for discussion in these columns.

* * *

H. P. M., Royse City, Texas.

We are not familiar with the operation of the receiver which you mention, but if it is a regenerative receiver, under favorable conditions you should be able to receive foreign stations.

The fundamental wavelengths of an antenna 60 ft. high by 60 ft. long is approximately 160 meters.

We do not know of any radio telephone stations in your vicinity. The high power radiophone station at New Brunswick, N. J. has completed the radiophone tests which were on progress several weeks ago.

* * *

V. N., New Orleans, La.:

Primary 6" in diameter by 8" long, wound with No. 24 D. C. C., tap every 15 turns. Secondary 5" in diameter, 8" long, wind No. 28 double silk covered. No taps are necessary if you wish to work on 2,500 meters only. For best results, a .001 mf. variable condenser should be used in shunt to the secondary.

* * *

K. V. A., Stromsberg, Neb.:

In your consideration of the changes of capacity of an antenna due to variation in height, you have probably overlooked the fact that a vertical wire has capacity. As you increase the length of this wire, the capacity of the antenna increases slightly nothwithstanding the fact that the capacity between the horizontal wires and the earth decreases.

For method of obtaining the decrement of a receiver, you are referred to "Practical Wireless Telegraphy" by E. E. Bucher, and "Radio Instruments and Measurements," Wireless Press, N. Y. C.

A Lepel arc will not operate satisfactorily on a rectified alternating current.

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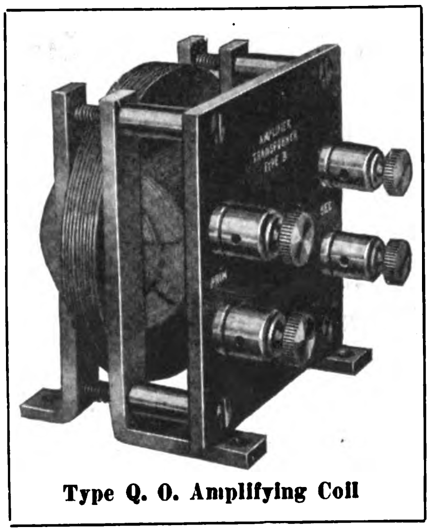

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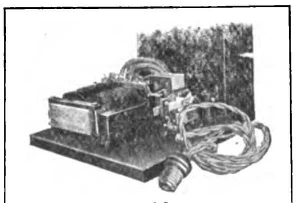
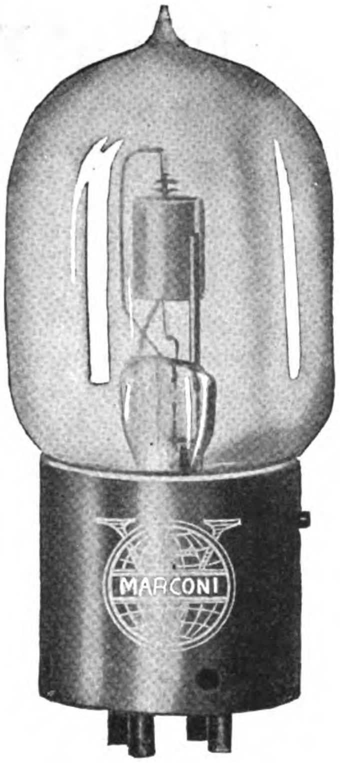


Rectifier



Fleming Pat. No. 803,684
De Forest Pat. Nos. 841,387-879,532

A WARNING

to Manufacturers
Importers
Dealers
Jobbers
Agents
Amateurs
Purchasers
Users of

Vacuum Tubes

The Marconi V.T. Patent isBasic

United States Letters Patent to Fleming, No. 803,684, November 7, 1905, has been held to be valid by Judge Mayer of the United States District Court for the Southern District of New York, and by the United States Circuit Court of Appeals for the Second Circuit.

It is a basic patent and controls broadly all vacuum tubes used as detectors, amplifiers or oscillions in radio work.

No one is authorized to make, sell, import or use such tubes for radio purposes, other than the owners of the patent and licensees thereunder. Any others making, selling, importing or using them alone or in combination with other devices, infringe upon the Fleming patent and are liable to a suit for injunction, damages and profits. And they will be prosecuted.

THE AUDIOTRON AND THE LIBERTY VALVE ARE NOT LICENSED UNDER THE FLEMING PATENT

The price of the genuine Marconi V. T. delivered is $7.00 each. The standardized socket is $1.50 additional. The standard resistance, complete, costs $1.00 and is made in the following sizes: ½ megohm, 1 megohm, 2 megohms, 4 megohms, 6 megohms.

Do not take chances by making, importing, selling, purchasing or using vacuum tubes for radio purposes not licensed under the Fleming patent. By selling, purchasing or using licensed tubes for radio purposes you secure protection under the Fleming patent and avoid the risk of litigation for infringement thereof.

This warning is given so that the trade and public may know the facts and be governed accordingly.

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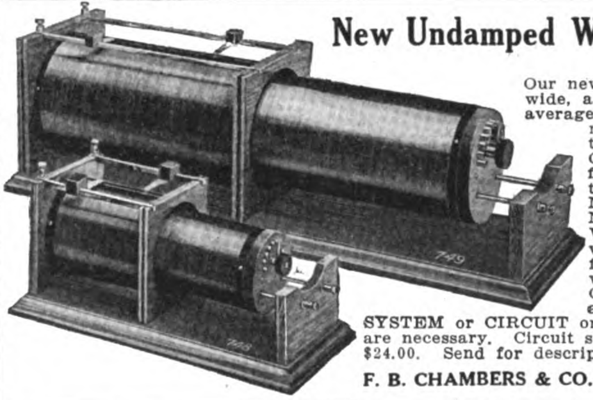

New Undamped Wave Coupler No. 749

Our new coupler No. 749 is 32" long, 9" wide, and 10" high, over all, and on an average-sized Antenna tunes to 15,000 meters. This coupler, used with the new CHAMBERS' SYSTEM or CIRCUIT, will bring in signals from domestic and foreign Arc Stations surprisingly loud and clear. Note the difference in size of our No. 748 and No. 749.
We claim to be the original inventors of a SYSTEM or CIRCUIT for the reception of the undamped waves without the use of Loading Coils or Oscillating Coils, as they are sometimes called; as with our SYSTEM or CIRCUIT only two inductively Coupled Coils are necessary. Circuit supplied with each coupler. Price $24.00. Send for descriptive matter.

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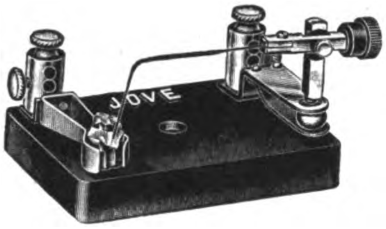

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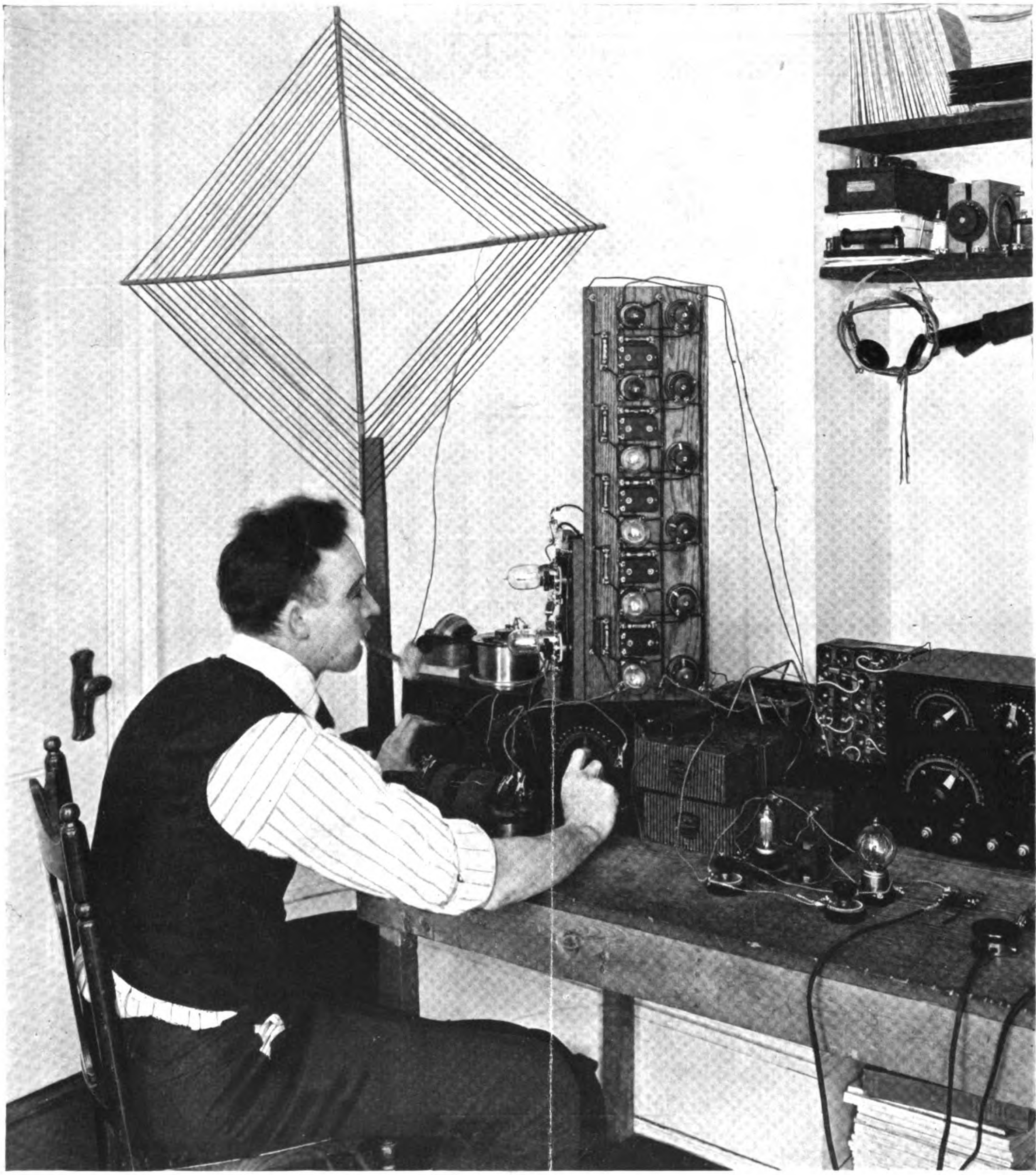

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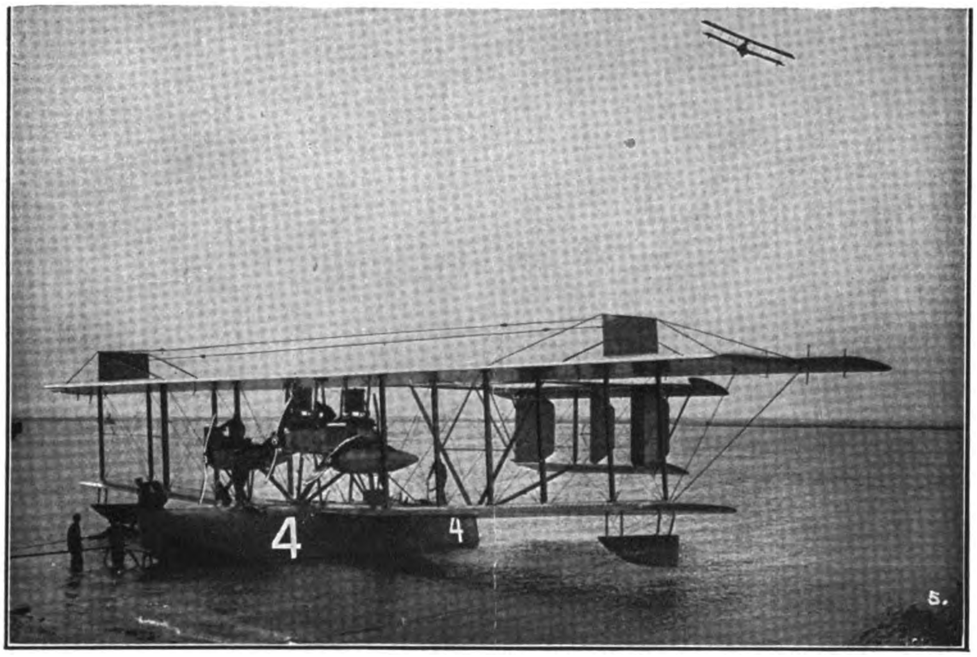

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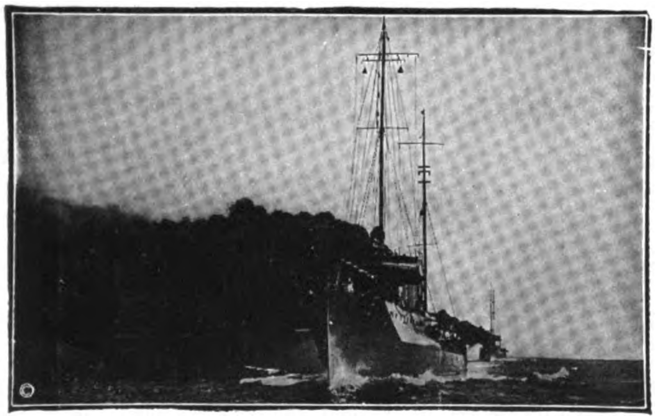

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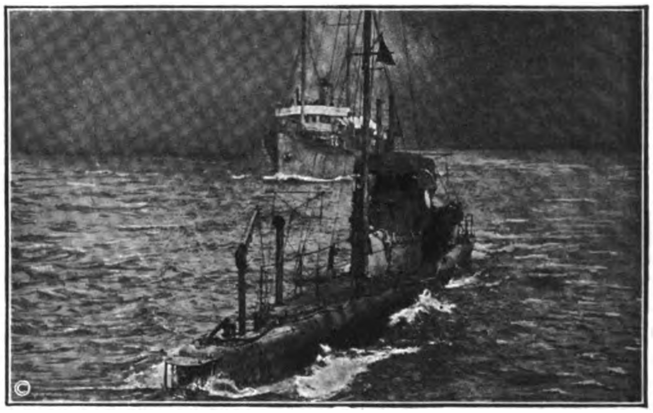

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The Wireless Age

Edited by J. ANDREW WHITE

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Vol. 7 No. 5

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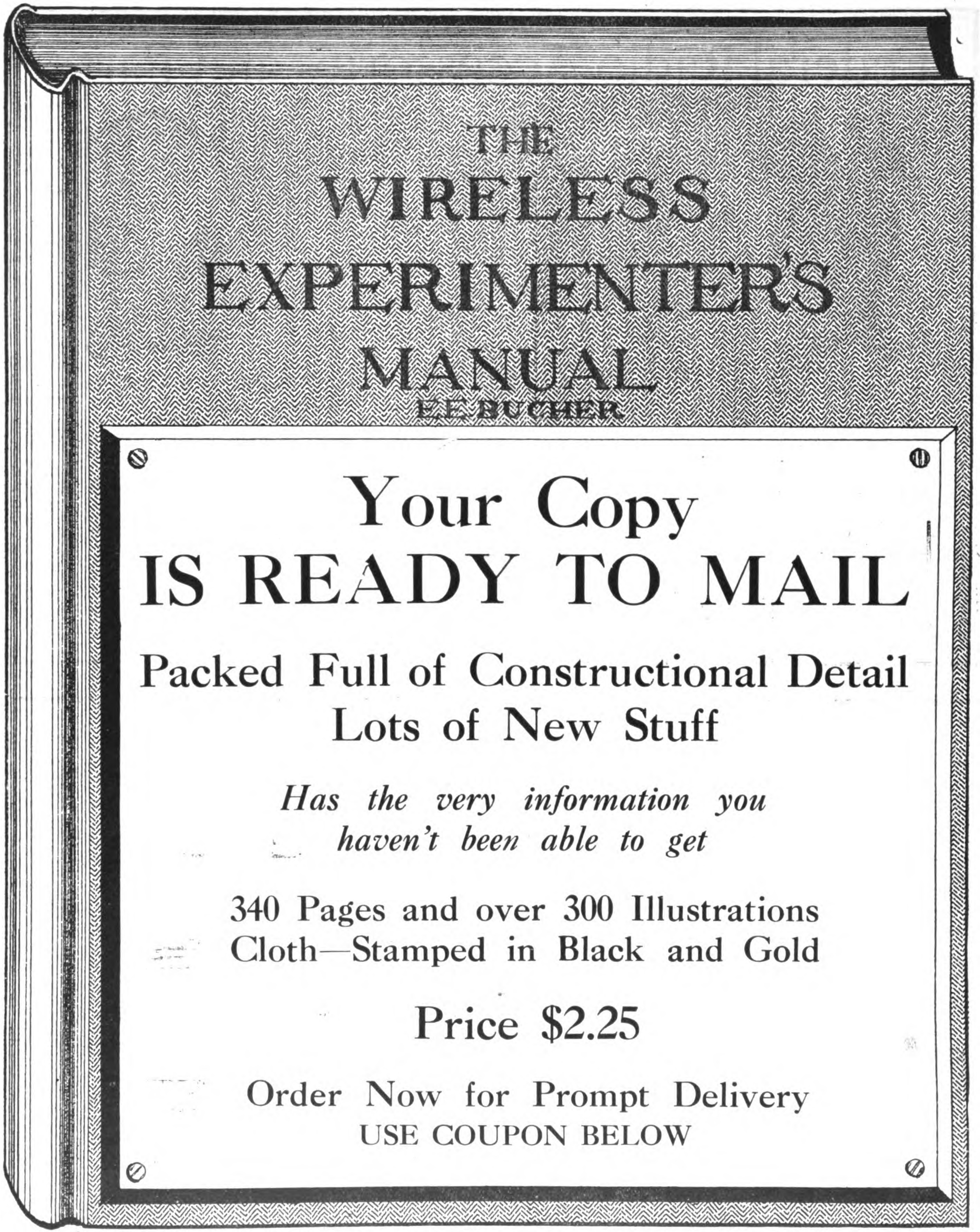

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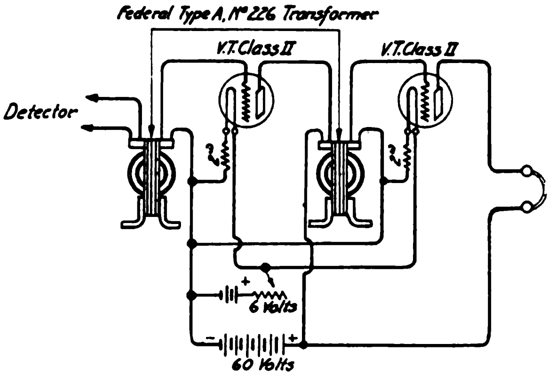

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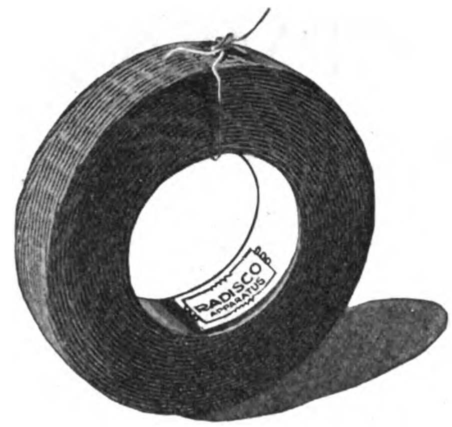

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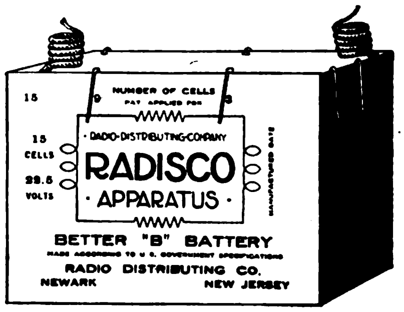

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If this page is cut out and appended to the same page cut from the editions to follow, a complete file of very interesting information will soon be available. (No. 2)

Vol. 7. No. 5. February, 1920

THE WIRELESS AGE

WORLD WIDE WIRELESS

Navy Ordered to Release Radio Stations Seized in War

NAVAL operation or control of all private radio stations, assumed during the war emergency, will be relinquished at midnight February 29, under an executive order made public by Secretary Daniels.

All stations taken over by the Government at the outbreak of the war are to be returned to their owners and all new stations built during the war by private concerns and which could not be operated because of the wartime restrictions, can be operated after February 29.

Under the order wireless communication reverts to pre-war conditions, and is subject to regulations of the act approved August 13, 1912.

Nine high-powered stations controlled by the Radio Corporation of America were taken over at the outbreak of the war. They are at Marion and Chatham, Mass.; New Brunswick, Belmar and Tuckerton, N. J.; Bolinas and Marshall, Cal., and Kahuku and Koko Head, Hawaiian Islands.

* * *

Transoceanic Radiophone in the Near Future

MARCONI prophesies that in the immediate future conversations between Great Britain and the United States will be carried on by wireless telephones and that the cost will be not more than 24 cents for one minute.

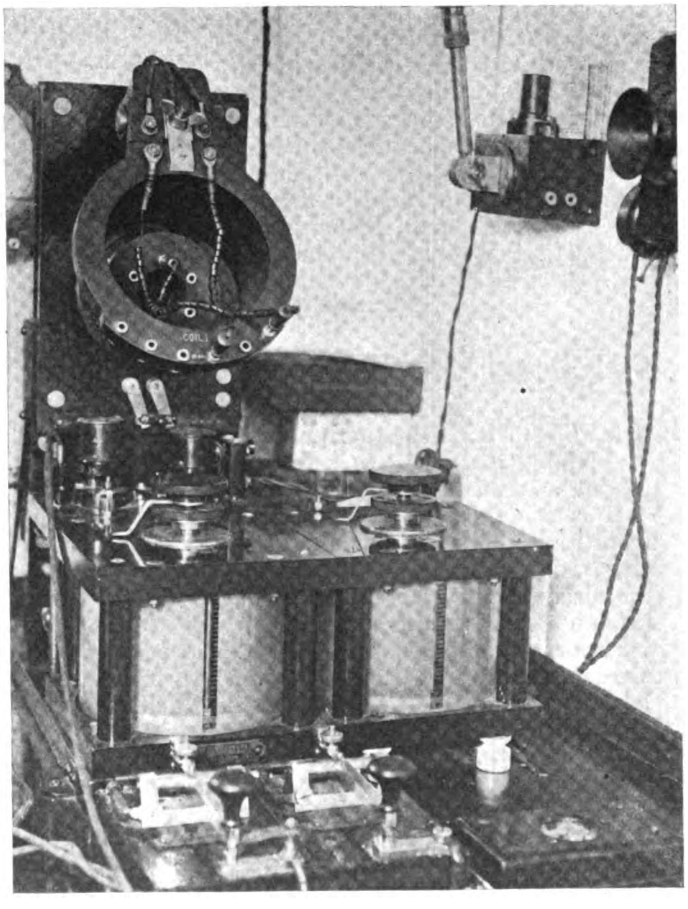
The inventor states that he has spoken directly to Canada from London, and adds: "It is only a matter of time when we shall be able to speak to New York from London. Already we have carried out many successful experiments between London and the Continent and we hope that we shall be able soon to announce the installation of a worldwide wireless telephone system in all countries interested. Our plans are developing rapidly."

Transoceanic conversations will be carried on through an ordinary telephone, the sending exchange being connected with the wireless station; at the receiving end the same method will be followed. Marconi already has applied for permission to erect a station in Norway to demonstrate his ability to talk across large expanses of water.

The cabled interview with Signor Marconi in London, in which the inventor of wireless was reported as saying that wireless telephone communication with New York would be shortly established, was shown to officers of the Radio Corporation of America.

"Every station in the country is under government operation," said David Sarnoff, commercial manager. "Until the stations are returned to us there can be no commercial arrangements made. I think the rate will be much higher than 24 cents a minute, as it will require a tremendous amount of power to send the voice across the Atlantic."

He said that the experiments referred to by Mr. Marconi were being made between the British and Canadian stations, which were no longer under government operation. Extensive plans have been made for some time for the establishment of transatlantic wireless telephone communication to be inaugurated as soon as possible after the great transatlantic wireless stations are returned to the private companies. These plans include radio exchanges which will transfer the voice from the ordinary land line telephone to the wireless telephone automatically. Under this arrangement it will be possible for a subscriber in New York to converse with a subscriber in London while using the ordinary telephone in the home or office.



The wireless set of the S. S. Alban, which accomplished unusual results in long distance receiving recently

Marconi's statement has provoked considerable discussion in London. A prominent official of the Central Telegraph Office pointed out that the Central Telegraph Office was handling on an average 12,000 messages more daily than in 1919. "All I can say beyond that," he added, "is that we have not yet ordered a hearse for the funeral."

The managing director of a cable company, mentioning that statements similar to Marconi's cropped up from time to time, said, "all we can do is to wait and see."

British Wireless Device Has Varied Uses

A REMARKABLE series of wireless experiments, just completed at Chelmsford, England, is the basis of an assertion that by a new wireless device big guns or hidden stores of explosives can be fired or exploded at long distance.

The original purpose of the Chelmsford test was to demonstrate a new device for giving aid to ships in distress at sea. The apparatus in its simpler form is intended to ring bells on board every ship within the wireless radius of the vessel sending out the distress call. It is with the extension of this idea, however, that an official of Marconi's Wireless Telegraph Company declared that such an apparatus in Paris could cause an explosion in Berlin. Also, it was asserted that an apparatus in an airplane could hover over an approaching enemy until his troops were over a previously hidden store of explosives and then destroy them.

It was stated that the instrument was used in experimental ways during the latter part of the war when fog guns some fifteen miles from shore were fired in the Channel by wireless rather than by a party of men despatched to the scene.

However, the principal use to which the device will be put is in merchant shipping, and the experiments at Chelmsford centered about such application.

Cable Delays to Be Relieved by Wireless Service on Pacific Coast

IMPORTERS and exporters in San Francisco are complaining that delay in transmission of their cables is costing a tremendous financial loss.

It is contended that cables to Honolulu are delayed from four to six days; to the Orient sixteen to eighteen days, and twelve to sixteen days to Australia. Some of the foreign traders here overlook the fact that radio service is now available to the Orient.

Importing and exporting firms have been advised to use radio instead of cable wherever possible. Arthur A. Isbell, division superintendent of the Radio Corporation of America, calls attention to the fact that the Japanese government station is open only ten hours a day for commercial business and that causes much of the congestion from that end.

Using radio instead of the cable would expedite messages; besides, radio is less costly.

Spanish Steamer Guided to Port by Wireless

GUIDED only by positions furnished from wireless stations ashore, the Spanish Royal Mail liner Leon XIII. arrived in New York, the first of a fleet of twenty-six vessels held up by a storm to get through quarantine.

When off the danger zone in the vicinity of Cape Hatteras the storm obscured the sun so that Capt. Francesco Murot, commander of the vessel, was unable to get his location. Grouping blindly along the treacherous coast the vessel was in constant danger of piling up on the rocks until the captain took advantage of the facilities for getting his position from the shore wireless stations.

Communication once established, the officers had no further difficulty in determining the whereabouts of the steamer.

Wireless Phone Talks Held Between Spain and England

SUCCESSFUL wireless telephonic tests have been made between the station at Arancuz, near Madrid, and Chelmsford, England, a distance of 700 miles. Conversations were carried on without difficulty.

New Orleans to Get Three Compass Stations

THREE compass stations are being built at the mouth of the Mississippi River. These will direct ships through raging hurricanes and fogs to New Orleans, the second port of America.

The installation of this apparatus will add millions of dollars to the shipping facilities of this port. It will revolutionize the handling of ships. Above all, the lives of men, who go down to the sea in ships, will be safeguarded more thoroughly than ever before.

Wireless Brings Aid to U. S. Navy Tug

A THRILLING tale of a battle with mountainous seas and 70-mile-an-hour gales, in which the Mexpet Company's giant oil tanker, George E. Paddleford, Capt. G. Duncan, turned to and went to the assistance of the disabled United States navy tug Undaunted, which was floundering around 20 miles east of Cape Hatteras, was learned on the arrival of the tanker at Providence.

Darkness added to the dangers in the attempt to rescue the helpless tug, which had lost its propeller. Twice, a steel hawser was gotten aboard the tug by means of floating a smaller line with the aid of a barrel.

Each time the heavy hawser was snapped by the plunging of the buffeted vessels. Only after a wireless message was received that the United States revenue cutter Yamacraw was coming to assist the disabled craft, did the tanker turn and proceed on her voyage to Providence.

Capt. Duncan received a radiogram from Capt. Tarbell of the Undaunted, expressing warm appreciation for his assistance about an hour after the attempt to rescue had been made and the tanker had proceeded on her way.

Navy Adopts Inter-Allied Wireless Procedure

A BULLETIN from the office of the Director of U. S. Naval Communications, Washington, D. C., announces that there will soon be placed into effect a new operating procedure. As a result of an inter-Allied conference, the Navy Department has decided to adopt as a basis for its radio procedure the so-called Inter-Allied W/T Procedure, which is indicated in M. P. L. Document No. 2, entitled "Inter-Allied W/T Instructions." The Fleet is using this procedure now.

The assignment of wave lengths for all stations, in accordance with the Inter-Allied Radio Conference, is being made. It is expected, in the future, that merchant ships and other commercial radio interests will have more wave lengths at their disposal. This can only be accomplished by reducing the navy's. However, it is believed that it will be some time before these wave lengths for shore stations will be effective, because it will mean doing away with the compensating wave on the arc, and adoption of a more selective transmitting apparatus than the spark.

The changes will be incorporated in a revision of the Communication Regulations.

Naval Stations Out of Commission

OWING to the continued shortage of radio personnel at Arlington Station (NAA) its radio activities these days is hardly worthy of mention. Naval men state, however, that they are trying to do their best under the circumstances to keep from being entirely forgotten by those who have been in the habit of listening-in and working with NAA, and hope that the proposed increases in pay will have the desired effect of bringing many of the old radio operators back to the service.

It will be noted that this station's work has been reduced to a point which is next door to going out of commission. The operators have not been standing watch for the reception of signals.

On account of the recent storm, Arlington has suffered the loss of all antennae. The reconstruction, it is said, may cover a period of at least two weeks.

Three of the four high-power naval radio stations on the Atlantic coast were out of commission as the result of the recent storm. The Radio Corporation of America's New Brunswick station was the only one in operation, it was said at the Navy Department, the Arlington, Annapolis and Sayville stations all being "down" as a result of ice forming on the antennae and the dislocating effect of the winds.

Repair of the Sayville station is going ahead. Considerable damage to ship and small shore radio stations also was reported. The damage was not sufficiently widespread to in any way threaten the safety of ships at sea.

◆

British Marconi Companies Declare Dividends

AT a meeting of the directors of Marconi's Wireless Telegraph Company, Ltd., held on December 17th last, a dividend of 7 per cent., less income tax, was declared upon the cumulative participating preference shares, on account of the year ending December 31st, 1919. An interim dividend of 10 per cent., less income tax, was also declared upon the ordinary shares.

These dividends were payable on February 2, 1920, to the shareholders registered on the books of the company on December 17, 1919.

With a view to the more equal distribution of the dividend on the ordinary shares, the Board decided to increase the interim dividend from 5 per cent. to 10 per cent.

On the same date the Directors of the Marconi International Marine Communication Company, Ltd., London, declared an interim dividend of 5 per cent., equal to one shilling per share, less income tax, upon the capital now issued and paid up. This dividend was made payable on January 15, 1920, to the shareholders registered on the books of the company on December 17, 1919.

◆

Ship Message Covers 6,339 Miles

A FAR-FLUNG radio message has been received by the Goat Island wireless station from the Pacific Mail liner Ecuador.

According to the message, the Ingleside station, near Los Angeles, picked up a message from the Ecuador giving her position as a few miles from Woo Sung, China, 6,339 miles from San Francisco.

Rivalry between ships of the Pacific Mail line for wireless supremacy has recently resulted in the Venezuela sending a message from a point 600 miles from Kobe, Japan, or a little less than 6,000 miles from San Francisco.

Hawaiian Station Picks Up Nauen Ten Thousand Miles Away

THE wireless station of the Radio Corporation of America at Koko Head, H. T., recently picked up and distinctly heard the station at Nauen, Germany, about twenty miles outside of Berlin, a distance of some 10,000 miles from Oahu. At the time a message in German signed "Ludwig" was being transmitted.

In addition to improvements which have been made in the receiving apparatus, the Weagant static arrester has been installed enabling the station to operate in practically any condition of weather. It will also do away completely with any intereference from Pearl Harbor or Kahuku. Equipment whereby Kahuku station will hereafter be operated by a land line from Koko Head is also being installed.

WIRELESS TOO THE PLANNUTS
REHSE
Copyright 1919 by The Press Publishing Company (The New York World)

"Hullo, Hank! How's yer wireless workin'? Get any flashes this mornin'?"
"Sure did, Patsy! Got one from three planets."
"What'd they say?"
"Wanted ta know what was good for the flu."

Armstrong Sues De Forest

THE suit entered against the De Forest Radio Telephone & Telegraph Company by Edwin H. Armstrong, originator of the regenerative circuit, promises to be the most interesting and important radio litigation since the Fleming valve case was decided by Judge Mayer. The complaint charges the De Forest Company with infringement of the regenerative circuit patent.

Major Armstrong, a former student under Prof. Pupin at Columbia University, served in the A. E. F. as Chief of the Radio Laboratories of the Signal Corps and was awarded the Legion of Honor in recognition of his distinguished services. His invention was used, under licenses, at the German radio station at Sayville before the war to receive trans-Atlantic messages from Nauen, Germany, and also by the Marconi Wireless Telegraph Company of America, now the Radio Corporation of America, which company is a licensee under the regenerative or feed back circuit patent. The invention was very widely used during the war by the U. S. Army and Navy.

French Station to Work 12,500 Miles

A GREAT wireless station five times the strength of the Eiffel Tower station, with a sending radius of 12,500 miles, or half way around the world, is to be built at Croix d'Hins, near Bordeaux, France. Its sending capacity will be 72,000 words a day.

◆

Suits Begun on Vacuum Tube Infringements

ALLEGING that the Fleming patent covering vacuum tubes used in wireless telegraphy has been infringed upon, the Radio Corporation of America has filed a bill of complaint and order to show cause why a preliminary injunction should not be granted restraining Rudolph Schmidt & Company, Inc., of Rochester, from manufacturing the tube. The case will be heard in equity in United States District Court in Buffalo.

Several cases in which the right to the patent by the Marconi Company is affirmed by the courts are attached to the bill of complaint.

Two Buffalo firms, the Bison Electrical Co., Inc., and McCarthy Bros. & Ford, Inc., are defendants in action for alleged infringement on a wireless apparatus patent. Papers have been filed in the office of the federal court clerk here by the Radio Corporation of America.

The bill of complaint charge the defendants with "making, using, offering for sale and selling apparatus" which in part, it is alleged, are copies of the patent.

◆

Portuguese Government to Buy British Radio Station

THE Portuguese Government is planning to buy from the British navy the wireless installation at Madeira for Porto Santo and procuring more powerful apparatus for Madeira.

◆

Sweden Wants Powerful Wireless Station

A MESSAGE from American Minister I. N. Morris at Stockholm states that Sweden wants a wireless station powerful enough to communicate with the world at large, and with the United States particularly.

The Swedish High Commissioner, Axel Robert Nordvall, who was in Washington at the time of the war, is at the head of the movement. The details have been worked out and the whole matter handed to the Government of Sweden, which it is understood will present a request to Parliament for $2,500,000 to erect this wireless station.

The promoters are anxious to have from the United States asurances that definite hours every day will be assigned to the Swedish wireless stations for sending and receiving messages from stations in America.

◆

Wireless Press Service to Rome

A SPECIAL wireless service between England and Italy for the use of the newspaper press was opened on January 6th by the English Marconi Company. This service, authorized by the Italian Government and the British Post Office, was instituted particularly to assist the Italian press in obtaining prompt reports of the Italian Prime Minister's visit to London. The Marconi high-powered station at Carnarvon is being used for the purpose and three hours daily have been allotted for this particular traffic.

German Wireless Messages Barred

ANNOUNCEMENT is made from Berlin that radio press dispatches to the United States can no longer be forwarded through the radio stations at Nauen and Elsenore on the ground that provisions of Article 197 of the Peace Treaty prohibit the forwarding of political, military or naval news. It is stated that the Interallied Naval Commission which recently arrived in Germany notified the German Government that the article was effective. As a result press dispatches to America have been returned and notice given that others dealing with the specified subjects will not be accepted.

The ruling creates a unique situation, so far as the United States is concerned, in view of a recent Washington report that relations between the United States and Germany will still be governed by the conditions of the armistice, under which the wireless stations were at the disposal of Americans.

While it is stated at the Foreign Office that Americans will be permitted to wireless commercial news, this will first be subjected to a careful scrutiny, which will involve long delays. The German Government's daily wireless report has also been abandoned.

◆

Radio Compass Stations Along Pacific Coast

EIGHT radio compass stations are in course of construction along the coast from San Diego to Alaska.

The radio compass station on the Farralone Islands is practically completed and will be in operation in the near future.

Stations are under construction at Pt. Reyes, Bird Island, Pt. Montara, Pt. Hueneme, Avalon, Pt. Firmin and Imperial Beach.

◆

Colombia to Have Two Radio Stations

THE Colombian Government has contracted for two powerful radio stations and a submarine cable from Colon to its north coast.

◆

12,500 Ships to Report Daily by Wireless

THROUGH an arrangement made by the Navy Department with the State Department, United States Consuls at the various ports throughout the world will send by radio or cable daily a report on various matters relating to ships. The Government agents will pay particular attention to the entrance and clearance of American ships in foreign ports and will expedite news of marine casualties and other items of interest to the shipping world. The information will be forwarded to New York and embodied in the daily shipping bulletin which is published by the United States Naval Communication Service.

At the present time the Navy Department is trying to keep track of 12,500 ships, flying the flags of all nations. Of this number 3,991 are American vessels. Under the new arrangement the American consuls will use the radio and cables to keep the shippers informed as to the operation of all vessels, so that it will be possible to tell at any time where any ship is located, whether she be discharging her cargo at Karachi or is on the high seas bound for some remote port.

A communication has been sent out to the various steamship companies asking them to assist by having each master report by wireless to the nearest station the position of his vessel once a day.

No charge will be made for either the radio or land wire service. At various intervals during the day, the naval radio stations send by direct land wire the positions of the ships, and all of these reports are incorporated in the bulletin, which is available to all shippers.

High Amplification at Short Wave Lengths

A Complete Description of Armstrong's Latest Contribution to the Radio Art, the Short Wave Amplifier

By Paul F. Godley

REGENERATIVE circuits, as adapted for amateur use, have gained wide and unusual popularity among amateurs, but there can be no question of the equal or greater attractiveness of the latest invention of Edwin H. Armstrong. He has developed a very effective means of amplifying short-wave signals and thereby opened up new fields of communication to amateurs who are in a position to supply themselves with the materials necessary to place the scheme into operation.

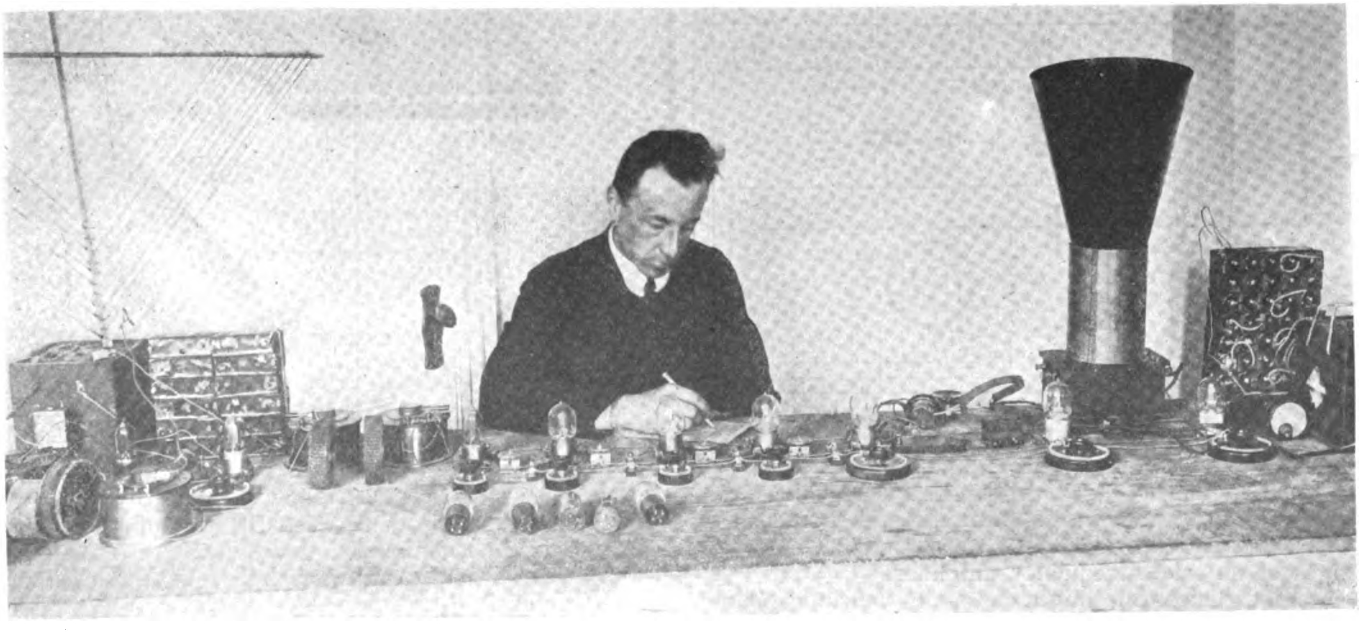
A great deal of progress was made in the various branches of radio during the war. Yet we now find, months after the lifting of the ban on transmission, that amateurs are still employing the circuits which were in use during 1915. These circuits are contained in a popular short wave regenerative receiver and a two-stage amplifier. It is well known that many attempts were made to further increase the sensitivity of amateur receiving equipment secured with this combination, and some very remarkable results were obtained by the use of three short-wave regenerative receivers in cascade, followed by two stages of audio-frequency amplification. But this arrangement, although extremely sensitive, was an impractical one, due to the complexity of adjustments. Even so, it is a fact that an eighth district station was consistently copied in the second district during the daytime.

More than two stages of audio-frequency amplification were not used because difficulties were encountered in getting more than two to function normally. When the third stage was added, tube noises and induced currents from local supply lines reached a volume which made it impossible to read weak radio signals.

The spirit of progress ever stirs uneasily within the amateur and developments made by the Allied Armies during the war were not overlooked; as a result, stories came into circulation some time prior to the armistice, that the British were using 19-, 29- and 36-stage amplifiers! It was reported that it had been found possible to copy, at London, the deck buzzers of the German fleet that lay in the Kiel Canal. Subsequently it was learned that this amplifier had been consummated at the 19th stage.

Since hostilities ended a great deal has been written about multi-stage amplifiers having resistance and transformer coupling for amplification at audio and radio frequencies, several different combinations and arrangements being possible. It was argued that the usable number of stages of audio frequency amplification was limited, for the reasons which have been mentioned, and the construction of a radio-frequency, transformer-coupled amplifier was also rendered difficult because the interactions which took place between the various tubes set up undesirable oscillations at both audio and radio frequencies. A seven or eight stage amplifier, therefore, became a very complicated affair, involving the use of four or five stages of transformer-coupled, radio-frequency amplification, a rectifying tube, and two or three stages of transformer-coupled, audio-frequency amplification. The construction of the tubes was an exacting task, as was also the construction of the transformers and the set as a whole. For this reason considerable attention was given to a resistance-coupled amplifier which had been developed.

This type of coupling, it appeared, could be easily adapted to the high capacity tubes that were being supplied from the United States, since by the use of these small coupling resistances stray electromagnetic and electrostatic fields of any great strength were elimin-



Complete arrangement of apparatus used in the Armstrong short wave amplifier, showing nine VT'S, one used as a detector, one as an oscillator, five as radio-frequency amplifiers and two as audio-frequency amplifiers ated. It also made possible a material reduction in the physical dimensions of the amplifier unit. Unfortunately, however, resistance-coupled amplifiers were not adaptable to radio-frequency amplification at the higher frequencies.

It was at this point that Major Armstrong developed the idea of changing the frequency of the incoming oscillations so that they could be satisfactorily handled by a resistance-coupled amplifier. This was accomplished by the use of a radio-frequency oscillator, so arranged with reference to the receiver circuit that oscillations were set up in the receiver circuit by the oscillator. These oscillations were of such frequency as to produce, in conjunction with the incoming oscillations, *radio*-frequency beats of an order that insured satisfactory passage through the resistance-coupled amplifier. This resulting frequency was then fed into the amplifier, and upon passing through several stages and reaching a sufficient strength, was automatically rectified and finally passed as an audio-frequency signal into two or more stages of an audio-frequency amplifier.

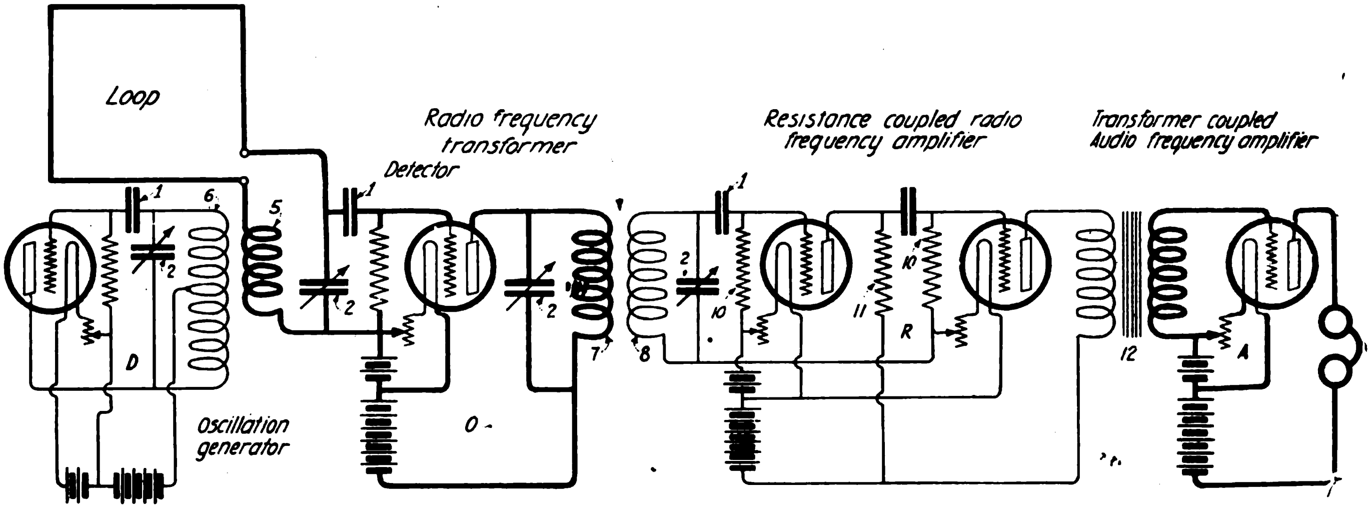

Loop
Radio frequency transformer
Detector
Resistance coupled radio frequency amplifier
Transformer coupled Audio frequency amplifier
Oscillation generator
D
O
R
A
1
2
5
6
7
8
10
11
12

Figure 1—Theoretical circuit diagram of the amplifier

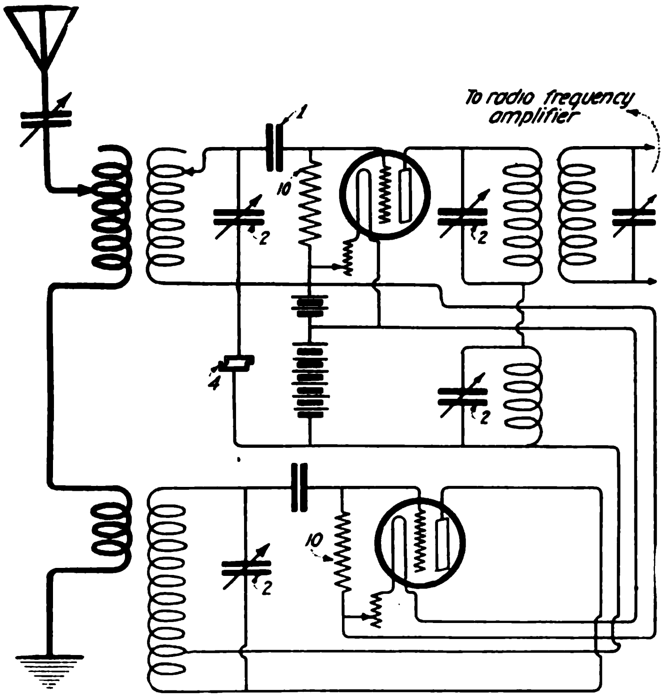


Figure 3—Scheme of connections for use with an antenna

At first glance, one might be apt to conclude that the use of this external heterodyne for the production of beats would annul the natural spark tone of the transmitter. This is not the case. The beats produced take place at a radio-frequency rate, and are thus inaudible, the beat-frequency current being, for all practical purposes, identical in form with that of the original incoming impulse. Thus, the outfit works equally well on spark and radio-telephone signals and is something which will be employed with wonderful success by the foremost amateurs.

The scheme makes it possible to amplify at high frequencies to an extent hitherto unthought of. This is evidenced by the fact that in the vicinity of New York City, on an eleven-turn loop about three feet square, stations in the fifth, eighth and ninth district may be picked up at the same strength as obtained by the use of an antenna, a short-wave regenerative receiver and a two-stage audio-frequency amplifier. It can be shown that the EMF generated in the three-foot loop is only about one per cent of that generated in the average amateur antenna. This makes apparent the possibilities of the scheme, when used in conjunction with an antenna.

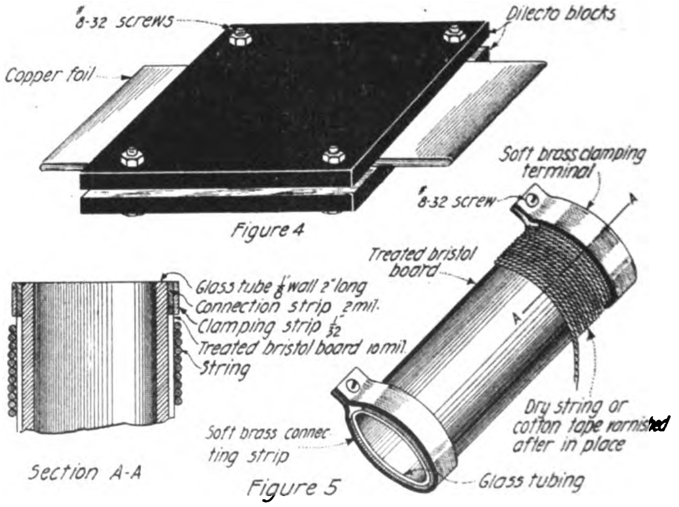
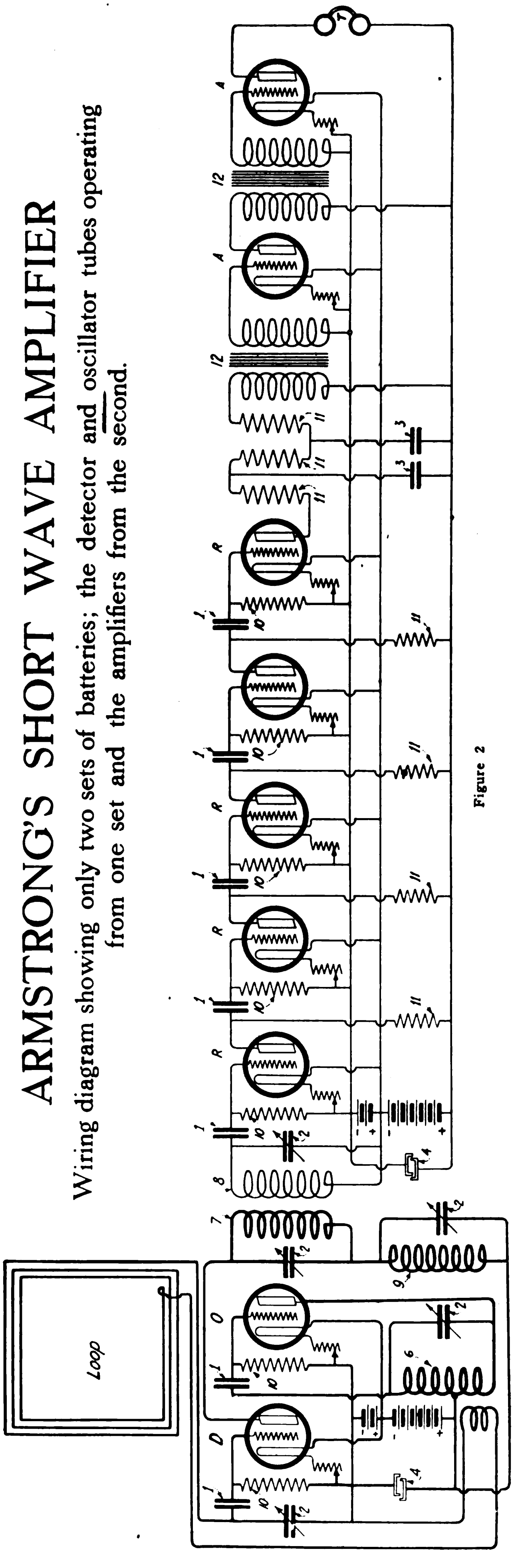

8-32 screws
Dilecto blocks
Copper foil
Soft brass clamping terminal
8-32 screw
Figure 4
Treated bristol board
Glass tube 1/8 wall 2" long
Connection strip 2 mil
Clamping strip 1/32
Treated bristol board 10 mil
String
A
Soft brass connecting strip
Section A-A
Figure 5
Dry string or cotton tape varnished after in place
Glass tubing

Figure 4—Grid condensers. Figure 5—Construction and assembly of the grid leak

Figure 1 shows a theoretical circuit diagram of the amplifier, where D is the detector tube, O the oscillator or external heterodyne, R the radio-frequency amplifiers, and A the audio-frequency amplifiers. In general, the action is somewhat as follows: The heterodyne O is so adjusted that beats between the incoming oscillation and the local oscillation take place at, say, a 50,000-cycle rate. The primary and secondary of the oscillation transformer 7, 8, are tuned to 50,000 cycles, and the impulses are passed to, and amplified by the radio-frequency amplifier. After sufficient amplification the potentials of the signal impulse reach a value so that one



ARMSTRONG'S SHORT WAVE AMPLIFIER

Wiring diagram showing only two sets of batteries; the detector and oscillator tubes operating from one set and the amplifiers from the second.

Figure 2

of the amplifier tubes acts efficiently as a rectifier. If the initial impulse is sufficiently strong this rectifying action may commence in the first tube of the amplifier, the succeeding tubes acting as both audio and radio-frequency amplifiers, or, as would be the case with weak signals, no rectifying action takes place until the last tube of the radio frequency bank is reached, whereupon the impulse is passed to the audio-frequency amplifier through an iron core transformer.

Figure 2 shows a schematic circuit diagram where only two sets of batteries are required for the whole system, the detector and oscillator tubes working from one set and the amplifiers from a second. As in figure 1, D, O, R, and A represent respectively the detector, the oscillator, the radio and audio-frequency amplifier tubes. Grid condensers (1) have a capacity of .00025 mfd. Figure 4 gives a suggestion for their construction. The use of 2-mil mica, two-foil plates 0.7 inch square will give approximately this capacity. Variable tuning condensers 2, as used by the writer, had a maximum capacity of .00075 mfd. Condensers in the filter circuit 3 are of the paraffin paper type and have a capacity of .005 mfd. By-passing condensers 4 have a capacity of 2 or 3 mfd. They are shunted around the battery and offer a low resistance path for the high frequency currents. Any resistance in the common battery will, in the case of several stages, result in self-oscillation in the amplifier.

Suggestions for the construction of the coupling inductance 5, and the oscillator inductance 6, have been given in figure 6. The former may consist of 10 turns of No. 18 DCC wire wound on a 3-inch tube 1½ inches in length. No taps need be taken off. The oscillator inductance consists of 40 turns No. 18 DCC wire, wound on a tube 4 inches in diameter and 3 inches in length. The tap is taken off 25 turns from the grid end of the coil.

The primary 7, and secondary 8, of the oscillation transformer may consist most economically of a 500-turn "honeycomb" coil arranged in each case so that coupling is variable.

The inductance 9, in the plate circuit of the detector, may be made by winding 30 turns on a 3-inch tube. Three or four taps, equally spaced, should be taken off. This inductance, with its condenser, is used for getting regenerative action—at the frequency of the incoming signal—in the detector tube. This regenerative action increases the signal strength to a very great degree and also makes the system considerably more selective. The inductance with its condenser may be replaced by a variometer.

Resistances 10 and 11 have values of 2,000,000 and 100,000 ohms respectively. Figure 5 gives suggestions for the assembly of the latter. Coat a strip of bristol board 2 inches wide with a solution made up by mixing six parts Higgins India ink with one part powdered graphite shaved from a grade H pencil. The mixture should be put on with a camels-hair brush, the brush being passed across the strip from side to side—not from end to end. After coating one side the strip is placed in a warm oven until dry, whereupon the remaining side is coated in the same manner. When thoroughly dry, a piece 1½ inches long is cut from the 2-inch strip and carefully wrapped around a glass tube ½ inch in diameter and 2 inches long on the ends of which two strips of thin, soft brass ⅜ inch wide, have already been placed (see figure 5). The paper is now clamped in position with a second strip of soft brass about 1/64 inch in thickness and ⅜ inch wide, as shown in figure 5. The space between the connector clamps is then covered with two layers of cotton or silk tape, varnished with Sterling or Ajax insulating varnish, and again baked until dry. The inner and outer connector strips are connected together. A strip of this same paper, coated only on one side and ⅛ inch wide by 1½ inches long, will serve for the grid leak 10. It should be so mounted as to be protected from moisture.

The two .005 mfd. condensers 3, and the three resistances 11, form a barrier beyond which the radio-frequency currents will not pass. Such a barrier is necessary in the case of many stages in the amplifier. Without it, self-oscillation due to inter-linkage of electrostatic and electro-magnetic fields of the radio and audio-frequency amplifiers respectively, will very likely take place, particularly when the operator wears the telephones and attempts adjustments of the apparatus.

The amplifier transformers 12 may be any of the types on the market. Although as many as eight stages of radio frequency may be used successfully, depending upon the class of tube employed, more than two stages of audio frequency cannot be used with success. In each case the limit is reached when tube noises, or noise due to induction from power lines, has reached a point where it is louder than the signal which one is after.

Figure 7 suggests a layout for the radio-frequency amplifier. As stated above, it need not be limited to five tubes; although in general five tubes of the kind that it is possible to procure on the market are all that can be conveniently used in connection with an antenna. The various units should be mounted in such a way that there is no leakage one to the other. In other words, the insulation resistance of the mounting should be high. This may be insured by the use of a dilecto panel, or if this is not possible, by mounting each unit on a small dilecto base of its own, and the various units on a hardwood board. Leaks, faulty batteries, faulty resistances and poor connections will give rise to noises which will rapidly multiply. Some tubes will be found to be noisy, too, and best results will be had only after tubes have been carefully selected or located where they will cause the least disturbance.

So much has already been published concerning loop construction that nothing will be said here as to details. For wave lengths between 200 and 600 meters, a flat spiral of 11 turns, whose outside turn is three feet square and whose turns are spaced ¾ inch will fill the bill. No. 18 lamp cord may be used.

Figure 3 shows a scheme of connections for use with an antenna. Here the oscillator is coupled to the system through the antenna circuit. To one who is not familiar with the operation of the outfit it may be well to start out with the antenna connection. The telephones may be inserted in the plate circuit of the detector tube until it is certain that the detector tube and the regenerative feature (if used), as well as the oscillator, are operating properly, or the primary of the first audio-frequency amplifier transformer may be connected in the detector plate circuit. The operation of the oscillator will be evidenced by a change in the spark tone of any incoming signals when the oscillator circuit is in resonance with the detector circuit. If no signals are available the system may be excited by a wavemeter. When the detector and oscillator have been brought into operation the radio frequency amplifier is placed into action. Very close coupling is used between 7 and 8 and the oscillator wavelength is varied for the best reception of signals. When signals become audible by means of this adjustment coupling at 7 and 8 is reduced and the two circuits are tuned. The oscillator is now readjusted for maximum signal, and the coupling between the oscillator and the system is varied for the best value; filament temperatures of tubes are adjusted, and the usual details looked after. Once a good value of coupling and adjustment for 7 and 8 has been found no change will be necessary over quite a wide range of wavelengths, and when once the signal is coming in on any wavelength it may be brought up to a remarkable degree by the use of the regenerative circuit (inductance 9).

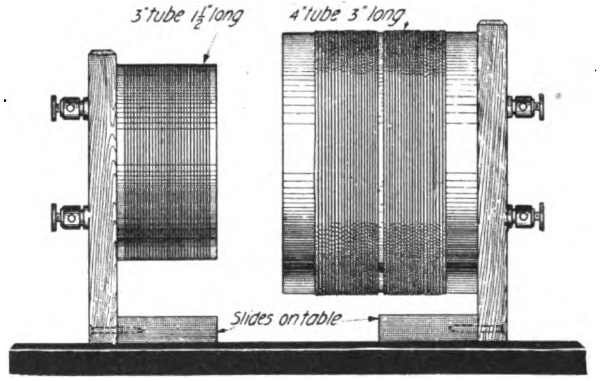


Figure 6—Showing method of mounting the coupling and oscillator inductances

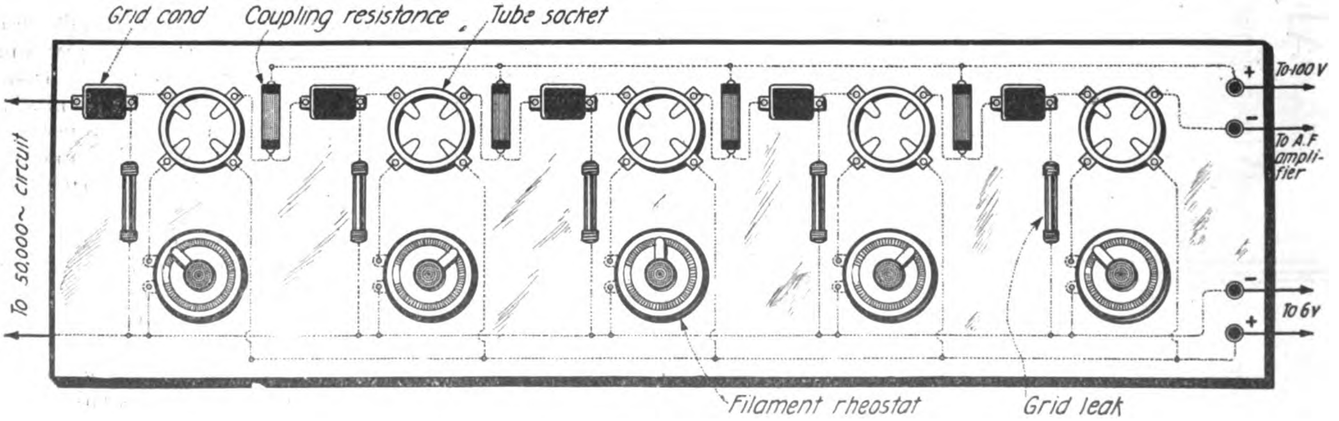


Figure 7—Panel layout for the radio frequency amplifier

While none of the Chinese amateurs have as yet been heard in New York City with this set-up, C. R. Runyon, Jr., and Minton Cronkhite, in suburban New York, report that eighth and ninth district stations are about "ten times as loud" as with a regenerative receiver and a 2-stage amplifier, while on "good" nights the writer, in Montclair, N. J., has been able to get fifth and ninth district stations on the loop with the same strength as was possible on an antenna and a regenerative receiver and 2-stage amplifier. When conditions are such that the last mentioned system brings in no distant stations, the connection of the antenna to the Armstrong amplifier system can be depended upon to bring them in numbers.

Prior to the war we had one case of direct communication between amateurs from coast to coast. It is to be hoped, and expected, that coast to coast communication will now become the rule. It will not be at all surprising if we are soon conversing with fellow amateurs in Holland and the British Isles.

Heterodyne Wavemeter

By R. W. Goddard

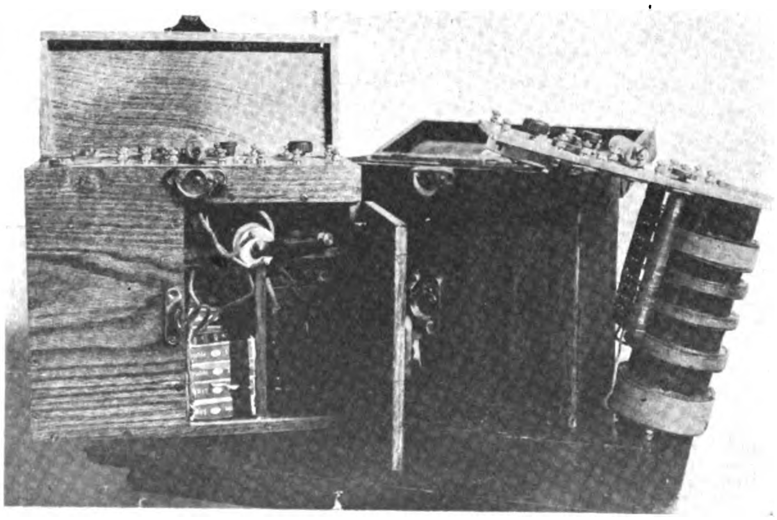
Dept. Physics & Elec. Engineering New Mexico College Agriculture & Mechanical Arts

THE wavemeter and high frequency ammeter are the principal measuring instruments used in radio work. The former is by far of greater importance and wider application. In principle this instrument is a simple radio or oscillatory circuit of known dimensions with some current indicating device inserted, attached, or coupled to it. Various designs of wavemeters, their theory and operation are shown in paragraph 30 of "Radio Instruments and Measurements," published by the Wireless Press, New York City, and will not be taken up here. With the recent introduction of vacuum tube oscillator and beat receiver systems these wave-meters fail to function as a universal instrument, being useless on sustained high frequency waves. A new type of instrument has to be used.

It was during the war while training soldiers for radio work that the attention of the writer was directed to this fact. As a result after three months of experimental work, a wavemeter was developed that fills the requirements of this new field and performs all the functions of the older type. The ideas and principles made use of are not new and the writer wishes to take no credit for any discovery. The aim of this article is rather to give to the amateur and experimenter a practical design of a new and necessary instrument, thus saving many the cost and labor of duplicating the experimental development work.

In principle this instrument is a vacuum tube oscillatory circuit of standardized dimensions. Oscillations of known frequency or wavelength are set up in the circuit by the tube. By placing the inductance of the meter in inductive relation with any other oscillating circuit, oscillations from it are induced setting up beat currents which within the range of audibility may be heard in the telephones of the meter. As the frequency of the meter oscillations is brought nearer to that of the unknown induced oscillations, the beat note lowers in pitch and finally disappears when the two oscillations are of the same frequency or wavelength. If the meter oscillation frequency is varied beyond this point, the beat note appears again and rises in pitch. As wavelength measurements are made by the nil method rather than the maximum as formerly, this instrument gives an accuracy impossible to obtain with the older type even with an experienced operator. By setting the meter to oscillate at any desired wavelength and reversing the procedure above, any oscillating receiver set or transmitter may be tuned in.

Not only does this instrument function as a meter, but it may be used as a beat receiver set or undamped transmitter. To illustrate the possibilities along these lines it might be mentioned that with a single wire antenna, 100 feet long and 20 feet high, connected to one end of the meter inductance, the other being grounded, YN (Lyons, France) and IDO (Rome, Italy) have been heard at State College, N. M., in the daytime, while all of the high power stations in this country are heard at any time. Using a 325-foot two-wire antenna 95 feet high connected with a ground wire across the inductance and tube, with a B battery pressure of 110 volts, signals were regularly sent a distance of two miles with a received audibility of 350. The receiving set used for this was of the static coupled regenerative type without amplifiers.



The heterodyne wavemeter, which may also be used as a beat receiver set or undamped transmitter

The material for the construction of the meter is given below:

One piece clear lumber 6 ft. long, 12 in. wide, ½ in. thick, preferably of oak; six 1x1 in. brass hinges with screws; 2 brass sash locks; 1 brass sash handle; 4 dozen 1 in. No. 7 brass flat head screws; Bakelite, hard rubber or fiber: one piece 13 x 5 x ¼ inches; one piece ¾ in, diam. 8 in. long; one piece 6½ x 2 x ¼ inches; one tube 3/16 in. hole, 1½ in. long; one 11-ohm, 2-ampere, back mounting, miniature rheostat; 1 potentiometer switch arm, graphite sector, and clips or instrument switch arm and 9 switch points; 1 vacuum tube; 1 vacuum tube adapter, holder or base; 1 piece 3 in. orangeburg fiber conduit 1¼ in. long; one 31-plate variable condenser in metal case; 1 piece spring brass or phosphor bronze, 2⅛x 2½ in.; 1 piece sheet copper 1½x8½ in.; 3 dozen 1 in. No. 8x32 round head brass machine screws; two 1½ in. No. 8x32 round head brass machine screws; 4 Hex nuts No. 8x32; 2 lbs. No. 24 B&S D.C.C. magnet wire; 1 pint orange shellac; ½ yard oiled linen or empire cloth; 12 No. 531 3-cell flash light batteries; 1 Exide or similar type 3 ZA 5 motorcycle storage battery; 1 pair 2000-ohm radio phones; 1 piece fiber sheet ⅛ in. thick 4x2⅜ in.

Figure 1 shows the construction of the case with compartments for the meter, telephones, B battery and A battery. Figure 2 indicates the location of the various parts of the meter. All apparatus is attached to the panel and forms a unit easily removed from the case for inspection or repair. The tube and holder shown is an Audiotron. The Western Electric V.T.1, DeForest V.T.21, and the new Marconi V.T. tube have all been used in these meters with negligible change in calibration. If the latter tubes are to be used, the four binding posts and holder shown may be omitted and a standard base mounted on the rear of the panel with the barrel projecting through. The cover of the case must then be made 2¼ in. deeper to accommodate the tube. The A battery rheostat is the ordinary 11-ohm, 2-ampere, miniature rheostat. The B battery potentiometer is a 5000-ohm graphite sector such as is supplied by all dealers of wireless goods. If desired, a circle of switch points can be used instead of this, with every other point connecting with battery taps. The binding posts may be of any variety, but a double post with a hole to receive the tip of a telephone cord is to be preferred.

The tuning condenser is of standard make, having thirty-one plates; fifteen 2½ in. diameter semi-circular movable plates, and sixteen 3 in. diameter semi-circular stationary plates. The bearings are mounted on hard rubber blocks bolted to the outside stationary plates. As purchased, these condensers have circular hard rubber panels to which the condenser body and stamped copper container are fastened by screws. By dissembling and using the condenser panel as a template, holes can be drilled and tapped in the meter panel to hold the condenser and metal container. A knob constructed of material cut from the drum switch body is utilized in place of that supplied.

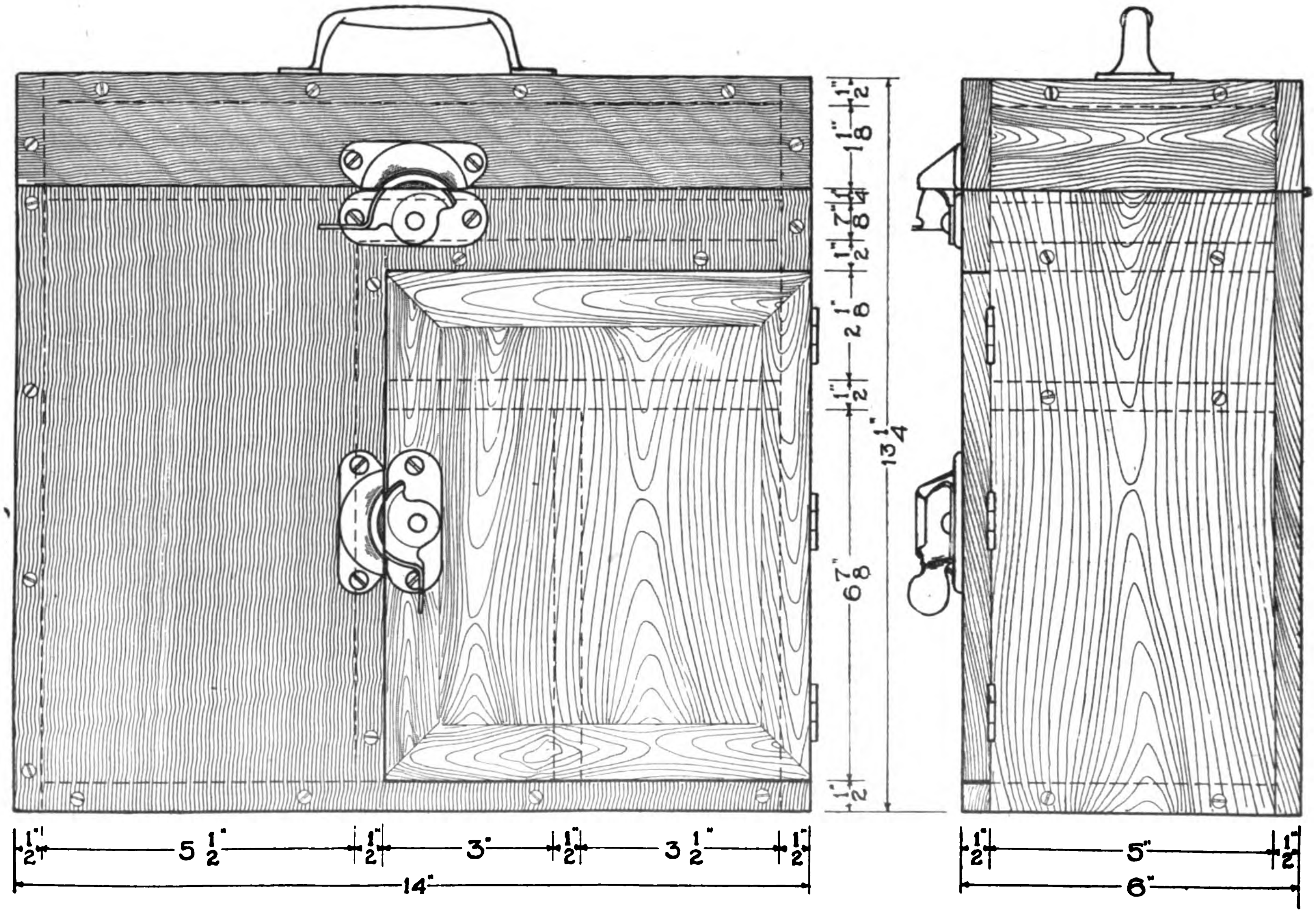


Figure 1—Construction of the case with compartments for the meter, telephones, B battery and A battery

The drum switch and bridging condensers are shown in figure 3. The switch body is constructed of ¼ inch fiber or bakelite; the drum is turned from the same material; the contact fingers are of sheet phosphor bronze and the contact plates are of sheet copper. The latter are fastened to the drum by pins at the corners driven into drilled holes. The bridging condenser is built up of two pieces of sheet copper separated with oiled linen or empire cloth, and are clamped between two thin pieces of fiber to the rear of the panel.

The inductance is wound upon a piece of 3 in. orangeburg fiber conduit such as is used by electric light and power companies for underground conduit work. Any electrical supply house can furnish this. Having obtained a proper length, place it in a lathe and turn out one end to a taper fit with the condenser container as shown. Holes should be drilled and tapped to bolt the drum switch to it so that the whole assembles together on the panel firmly and squarely. Then place the fiber conduit in a vise and start winding at the bottom. Using No. 24 D.C.C. wire, put on 50 turns, shellac it and cover with a piece of empire cloth, passing the wire through the lap and then put on 50 more turns in the same direction, but progressing from the upper end to the bottom. Shellac this and cover with another layer of empire cloth. Continue until eleven layers have been built up. Then proceed to the next coil of 18 turns, eleven layers, and then to the middle coil of 10 turns, eleven layers. From this coil a tap should be taken out at the end of the sixth layer. From the end of this coil proceed on to the others as shown. A good way to secure the ends of the coils to prevent them from unwinding is to place about the wire a piece of linen or friction tape about 1½ in. long, doubling it back on itself forming a tab. The winding is then started, each turn passing over the ends of the tab and holding it in place. At the end of a coil place the tape loop in position fifteen to twenty turns before the last with plenty of length and the tape ends protruding. Then wind over the tape as before, passing the last turn through the loop. Pull the loop up tight by the

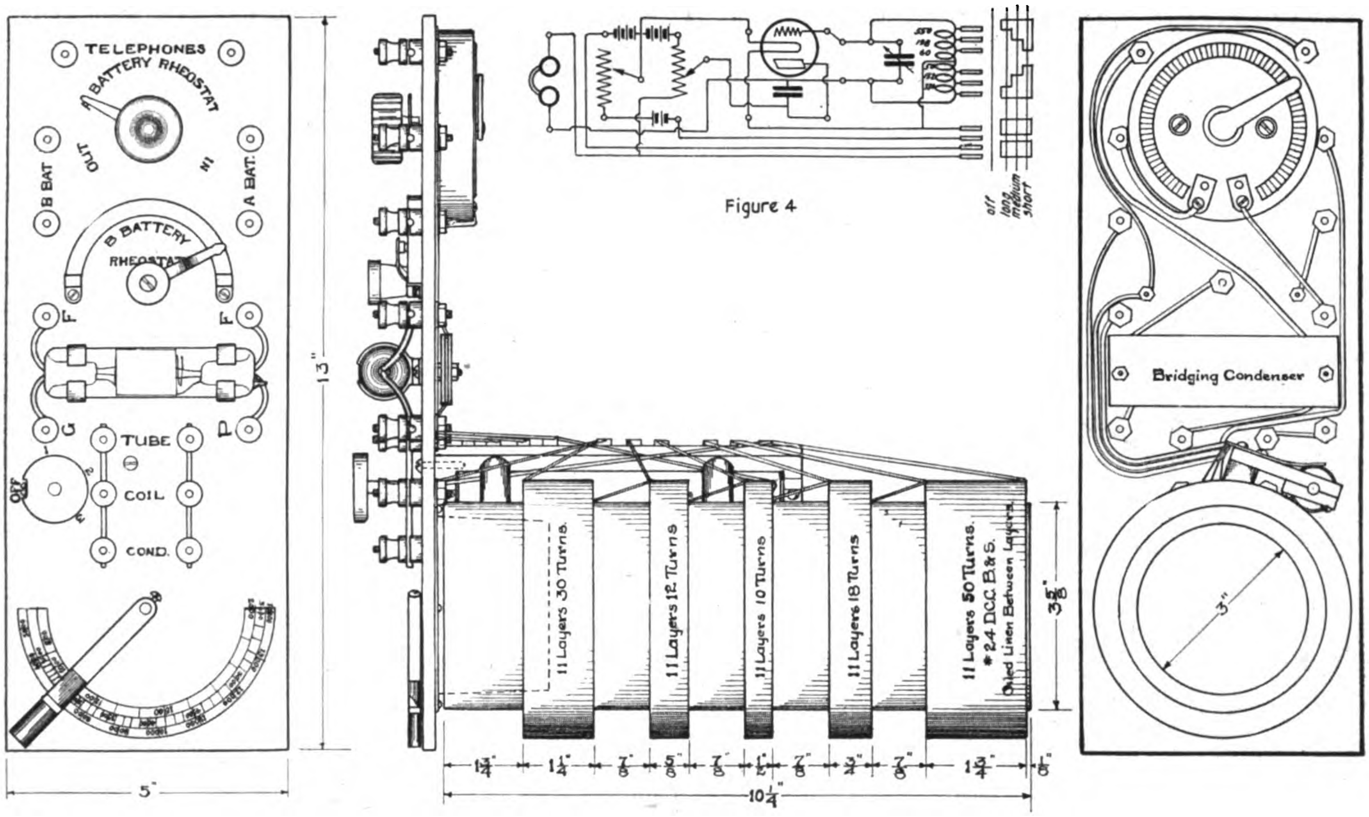


Figure 2—The location of the various parts of the meter according to scale. Figure 4—Wiring diagram showing all connections

ends and cut them off flush with the winding. After the shellac has hardened the ends cannot be pulled loose without tearing the tape in two.

The wiring diagram, figure 4, shows all connections. All joints should be well soldered and taped. The use of cotton sleeving or empire cloth tubing on the connections improves the appearance. Make all connections as short as possible.

Before finally assembling the panel should be marked. The wavelength scales under the condenser handle will have to be scratched in with dividers as four semi-circles, the calibrations to be placed later. The lettering is best done with steel stamps such as are used in machine shops for marking tools, etc. The letters may be filled in with white ink to make them appear plainer, if desired. When all is finally assembled the meter should be calibrated by comparison with any other wavemeter, or sent to one of the various State Universities or the Bureau of Standards for calibration. If constructed as shown, no trouble will be experienced with a good tube in producing strong oscillations throughout the range of the meter, as the windings have all been carefully worked out for the best results.

With modern ratio apparatus this instrument must of necessity be fundamentally important. Yet to my knowledge there is none on the market at the present time. For the earnest experimenter of limited means, no single piece of apparatus could be more highly recommended, since it is not only fundamentally a wavemeter, but it may be used as a receiver or transmitter for both damped and undamped waves in telegraphy or telephony. The wiring is also arranged so that the tube and its accessories, the inductance, or the condenser may be used independently.

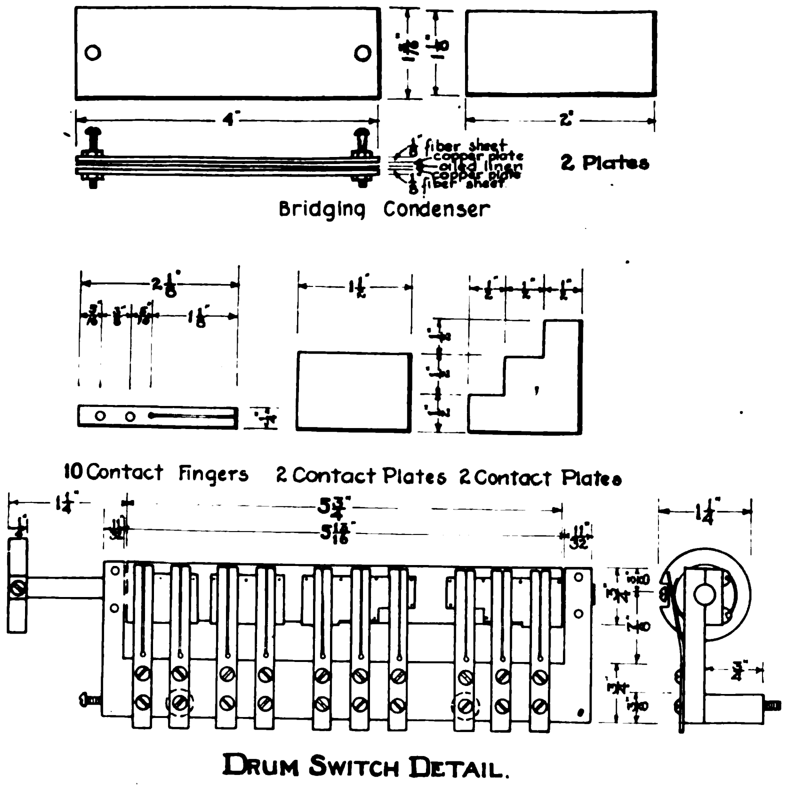


Figure 3—Detailed constructional plans of the bridging condenser and the drum switch

Combined Kick-Back Preventer and Switch Panel for Experimental Radio Stations

By J. A. Weaver

SOME form of a kick-back preventer is a necessity in every well appointed radio station, and as pointed out in the article, "The Fire Underwriters' Rules Applied to Amateur Stations," which appeared in the March issue of the Wireless Age, the code calls for a transformer in the circuit, or two condensers across the line in series. However, the high resistance shunt is entirely satisfactory, is in general use in commercial stations, and also seems to be the type in general favor amongst amateurs. It is also relatively cheaper and easier to construct and occupies less space than any other type. For these reasons it has been selected for use on the panel about to be described. The form of the resistance elements here suggested is somewhat novel, as will be seen when we take up their construction later on. The idea of grouping the kick-back preventer and several circuit switches on a single panel will be found to have many advantages, as it not only follows good electrical practice and presents an attractive appearance, but also is very handy from the operating point of view. The panel is intended to be mounted in a sheet-iron cabinet with hinged cover to conform with standard practice, and this cabinet can then be mounted in the handiest position available, either upright on the floor or inverted on the under side of the operating table close to the front edge, so that the circuit switch may be used to start the rotary gap motor with ease and dispatch. Of course, if more than two circuits are desired, the panel may be easily designed to accommodate the desired number, but two switches, one for the transformer circuit and the other for the rotary gap circuit, are usually all that will be desired, and they make a symmetrical design. The concentrated and individual control of the rotary and transformer circuits will be greatly appreciated in use, as it allows one to instantly cut out either circuit while adjusting the gap or making other adjustments, thus avoiding the danger incident to the accidental closing of the key. Having the circuit separately fused, and the fuses close at hand will avoid much annoyance when one happens to blow, as it can be instantly located and removed without journeying to the basement or other remote fuse location. If this panel is fed by a separate pair of feeds direct from the meter it will make current supply to the radio set entirely independent of the rest of the house and allow complete control of the circuits from the handiest single location possible.

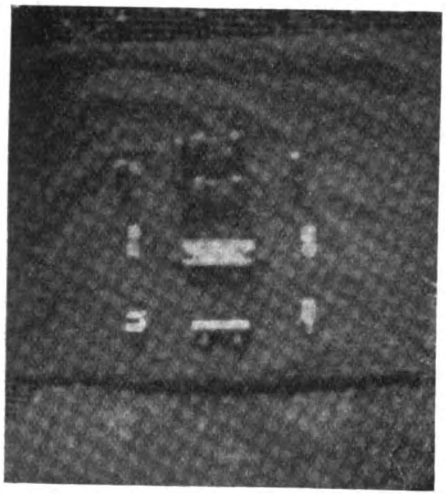


Figure 3—Front view, showing finished panel

The material necessary for construction is as follows: One piece of polished slate 18½ inches long by 9 inches wide by 1 inch thick. One piece of hard drawn copper tubing 7 inches long by 5/16 inch outside diameter. One piece of hard copper strip ½ by 1/16 inch and 5 feet long. Two 30 amp. two-pole spade handle, panelboard knife switches. The hinge jaws of the switches should be equipped with lugs for attaching to fuse clips, and the other set of jaws should be also equipped with lugs for taking a binding post thumbnut. Some makes of switches do not have these lugs stamped out of the same piece as the switch jaw, but use separate little pieces of copper strip for the purpose. In buying this type be sure to get four for each switch; six individual switch jaws, three with lugs for attaching to fuse clips and three without will also be needed; fourteen 30 amp. fuse clips; seven cap nuts 10-24 thread; seven machine screws, either iron or brass 10-24 inch and a half long round head; half dozen 8-32 battery nuts; two dozen brass or iron machine screws round head ¾ inch long; four like the last, but 1 inch long; four thumb-nuts 8-32 thread; three lugs for busses. Some burrs and a little sealing wax complete the list, exclusive of the fuses and resistance elements.

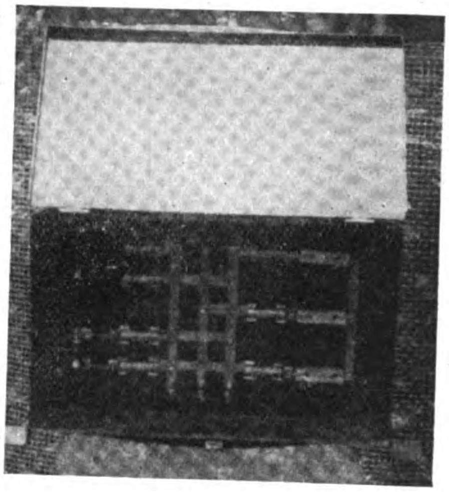


Figure 3—Rear view of panel, showing all parts in place

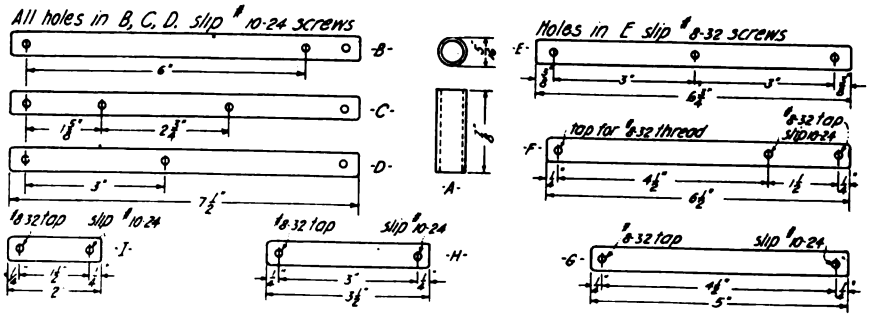
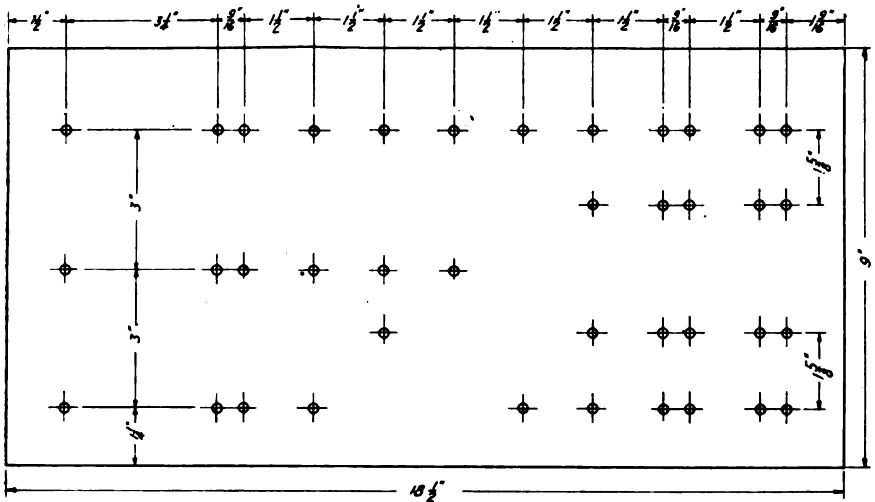


Figure 1—Detailed construction of various parts

The first thing to do is to cut the copper tubing up into seven pieces with a length of ⅞ inch as shown in the sketch at "A," figure 1. These pieces should have the ends cut square and if available a lathe should be used for the purpose, but if they are cut with a hack saw be careful to cut square and finish up with a file. If the tubing is held in a vise while cutting, a piece of iron rod should be inserted in the tubing, where it is gripped by the vise jaws to prevent crushing. These pieces are the pillars to support the buss bars. Now cut the copper strip up into pieces of various lengths as indicated in the drawings, figure 1. Make two like "G," two like "I," and one of each of the rest. "B," "C" and "D" are buss bars, "E" is the connecting bar for the three resistance unit clips, "F" is the lower circuit connecting bar, "G" shows the two inner circuit connecting bars, "H" is the center ground terminal connecting bar, "I" shows the two upper circuit connecting bars. The ends of the bars should be filed smooth and square, and the corners slightly rounded. The location, size of holes and those which should or should not be tapped are clearly given in the dimensions on each piece shown in figure 1. After all the parts mentioned and shown in figure 1 have been made, they, with the rest of the copper parts, should be polished and lacquered. In buffing the parts do not bend the bars. To avoid this it is best to drive a small brad in a piece of board and place the bars on the board with the brad protruding through a hole to hold them when they are brought against the wheel. This will allow you to use as much pressure as necessary without bending. Clear lacquer should be used, as gold lacquer does not look well on copper. The parts should be slightly warm when lacquering, but not so hot as to scorch the lacquer. If no means are available for polishing the copper parts it will pay you to have it done at some plating shop, because the whole appearance depends on nicely polished metal, which, contrasted with the glossy black finish of the slate panel, makes the whole job "a thing of beauty and a joy forever."



Corner holes slip #14-20 mach. screw. Holes for buss supports #10-24 mach. screw. All other holes slip #8-32 mach screw.

Figure 2—Dimensions for constructing the slate panel

While the lacquer on the metal parts is drying you can turn your attention to the laying out and drilling of the slate panel.

Procure a sheet of thin cardboard or heavy paper and cut it to the dimensions of the panel. Lay out the location of each and every hole to be drilled as shown in the drawing, figure 2. The drawing is complete and dimensions are also given, so it should not be difficult to lay out the template. After the template is laid out arrange the various parts on their respective locations and check up the accuracy of the holes as they are marked on the template. Remember, a correction can be easily made on the template, but when a hole has been spotted or drilled in the slate or marble board it is another and a sadder tale! If the template is of cardboard, as in this case, it is laid directly on the front face of the panel and clamped in position. Take a prick punch, or a center punch ground to a sharp point, and mark through the cardboard onto the panel with a light tap of a hammer. The cardboard template is removed and the punch marks spotted. After "spotting" the panel is ready for drilling, which can be done best on a drill press, but if necessary a breast drill can be used. Lay the slate on a flat board and drill on the "spots." Use a drill having the cutting lips ground at a short angle and run it at very slow speed, using water as a lubricant. Use moderate and steady pressure. When nearing the completion of a hole release the pressure and let the drill come through by the weight of the drill press handle or with a very light pressure. This will prevent a jagged hole on the other side. Drilling slate or marble is like drilling wood unless you strike a metal vein. Then it is worse than the hardest steel, and drill after drill will be caught and nicked or broken in getting through. It is customary to bush a hole if the vein is bad. When the panel has been drilled from the front clean it off and turn it over on a clean piece of tissue paper laid on the wood board, and with a ½-inch drill or larger countersink all holes but the corner ones for a depth of about ⅝ inch. The edges of the slate, if rough, should be filed smooth with a large flat file having rather coarse and single cut teeth.

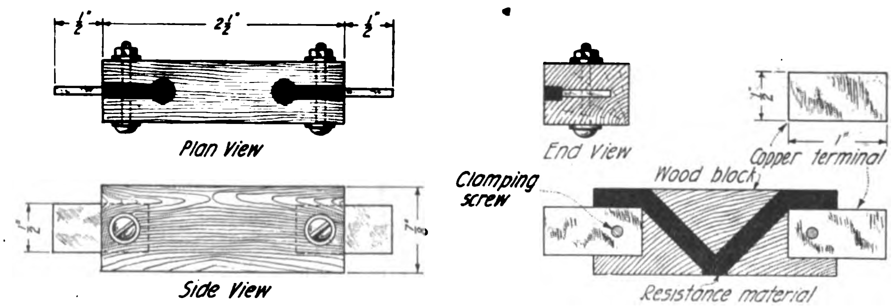


Figure 4—Constructional plan of the resistance element

After the filing is finished the parts may be mounted. Mount the switches first. Each screw should have a burr slipped on it to give a good bearing to the screwhead in the bottom of the countersunk holes. The panel should be propped up on edge so you can get at both sides at once, thus making the mounting an easy matter. After the switches are mounted make sure they work smoothly before finally setting up tight on the screws. In mounting the fuse clips snap a fuse in place to keep the clips in proper alignment when tightening the holding screws. In mounting the clips for the resistance elements follow the same procedure, using a piece of metal to keep them in line. The buss bars are put into position by inserting the long 10/24 screws through the holes in the slate and connecting bars from the back of the panel. Slip a copper pillar over the projecting end of the screw and place the buss bar in position with the ends of the screws through the holes in same, and then screw a cap-screw on the end of each screw. The upper pillar of the central or ground buss should have several burrs placed under it to account for the thickness of a connecting bar which is lacking here, as this pillar is only for mechanical support of the middle buss. By referring to the photo in figure 3, which shows the finished panel with all parts in place, the proper position for each part will be clearly seen. When all parts are mounted the countersunk holes are filled with sealing wax.

The material necessary for the construction of the resistance elements follows: One strip of hard wood (maple preferred) ⅞ x ⅝ x 7½ inches long; one piece copper strip ½ x 1/16 x 6 inches long; six battery screws and 8-32 nuts; some burrs and a small quantity of plaster of Paris and lamp blank.

Cut the wood strip up into three pieces each 2½ inches long. Slot the ends of each piece with a thin bladed saw for a distance of half inch, as shown in the drawing, figure 4. After the copper strip has been cut up into the six pieces, each one inch long, a piece is driven into the saw slot in each end of the wood blocks. A hole to slip an 8-32 battery screw is drilled through the wood and the copper piece from the side of the block, the screw is inserted and a burr and nut put on the projecting end and drawn up tight. Now, on one of the narrow sides of the block mark the center, and drill through it on an angle with a quarter inch drill, so it will come out on top a half inch from the end, or right beside the inner end of the copper terminal piece. This is made clear in the sectional view of the resistance element in figure 4. Each end of the three blocks is treated in the same way. On each of the blocks where the two holes meet at the center on the bottom of block trim the edges of the holes with a penknife so it will be a single hole and deepen it somewhat so that when the compound is pressed in, it will join the ends of the "V." Trim the edges of the holes where they come out on top and cut a slot over the top edge of the terminal piece so that the compound will get a good contact with same when filled in place. This is also shown in the sectional view of the resistance elements in figure 4. The resistance material is a compound of plaster of Paris and lampblack mixed dry and made into a paste with a little thin shellac as a binder. The resistance of the compound when dry and made into a rod four inches long by a quarter inch diameter should be about 5000 ohms or even greater. It will stay across a 110-volt line indefinitely without heating—the condition it must meet in service. No exact proportion of ingredients can be given. Much depends on how well they are mixed and only a small amount of lampblack is necessary. It is necessary to make up a few batches of different proportions for testing before the right combination is found. It may be stated that the method and ingredients for making the resistance elements is only offered as a suggestion and there is plenty of room for originality. Graphite from a very hard drawing pencil finely powdered may be substituted for the lampblack and whiting could be used instead of plaster of Paris. The method described has been found satisfactory, but another and much used method of creating a high resistance is to paint the space between the two contacts with a coat of flake graphite and alcohol, putting it on in an extremely thin coat and giving one coat after another until the right resistance is created. This method may be applied with little change in the form of the wood blocks. When the compound is dried out and perfectly hard (which will take a long while) the wood blocks can be given a coat of asphaltum paint.

The sheet iron cabinet for the panel which is shown in the photo, figure 3, is made of No. 14 gauge metal having a hinged cover and snap catch to hold it shut. The feet are made of two pieces of 2-inch light angle iron riveted to either end to keep the bottom of the box raised a short distance from the floor. Holes are provided in the end and bottom for the entrance of wires. The inside dimensions are 19½ inches long by 11½ inches wide by 4 inches deep. The panel is mounted in it with four 14-20 machine screws. It is beyond the ability of most amateurs to make the metal cabinet, so specifications sent to a sheet metal shop is the best plan. A wooden cabinet lined with asbestos or metal could be substituted if desired. In conclusion, it may be mentioned that the fuses used for the kick-back preventer should be not over 3 or 5 amp. The others should be of proper size to protect the apparatus in each particular circuit.

The Regenerative Receiver vs. Cascade Amplifier

The Relative Merits of Those Vacuum Tube Circuits for Radio Reception at Amateur Wave Lengths

By Howard W. Lewis

In order to intelligently discuss the respective merits of the regenerative vacuum tube receiver and the cascade vacuum tube amplifier for radio reception at amateur wave lengths, it must be considered that amateurs are practically limited to the use of spark sets and that undamped wave transmitters at short waves are still in their infancy. The present question, therefore, narrows down to a consideration of damped wave reception at high frequencies. Obviously, if continuous waves are to be received, an oscillating audion circuit is required, either with or without additional audio frequency amplification.

Let us now examine the circuits employed in each system. Figure 1 shows a typical regenerative receiving circuit in which the vacuum tube is caused to oscillate by means of electromagnetic "back coupling" between the "tickler" coil (T) of the plate circuit and the secondary (S) of the receiving loose coupler. Detection, amplification and generation of local oscillations occur simultaneously in this tube and its associated circuits. Figure 2 shows the form of single step cascade vacuum tube amplifier usually adopted by amateurs. In this arrangement, tube No. 1 acts as a detector and tube No. 2 as an audio frequency amplifier. These two

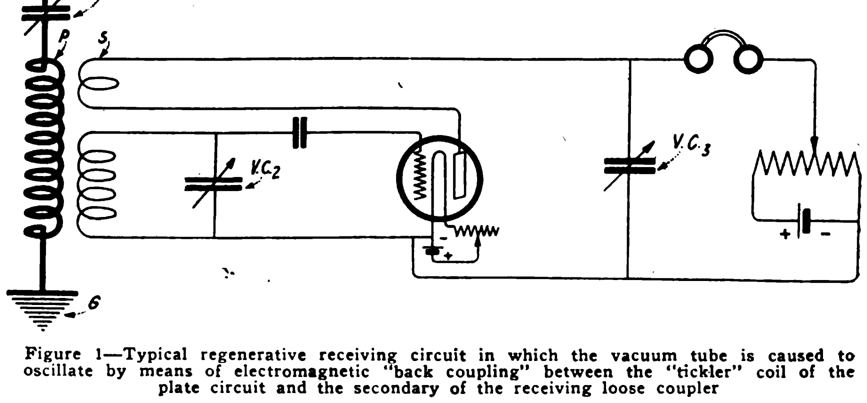


Figure 1—Typical regenerative receiving circuit in which the vacuum tube is caused to oscillate by means of electromagnetic "back coupling" between the "tickler" coil of the plate circuit and the secondary of the receiving loose coupler

tubes or stages are coupled together by the transformer (T). There should be no locally generated oscillations. The same antenna, loose coupler, and primary and secondary variable condensers are used in either case.

The following interrelated factors will be discussed in order to form a basis for comparison:

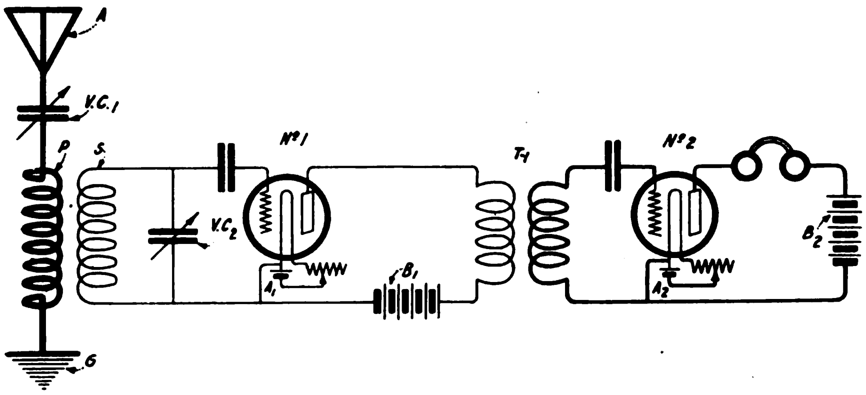


Figure 2—Single step cascade vacuum tube amplifier

1. Results obtainable.
2. Simplicity.
3. Ease of construction.
4. Ease of manipulation.
5. Quality of signal note.
6. Interference.
7. Reliability.
8. Cost.

In the hands of a skilled operator, particularly one who thoroughly understands all the necessary adjustments, excellent results can be had from either of these circuit arrangements. In the majority of cases, particularly for the amateur and often for the expert when time does not permit of careful tuning, much louder signals are obtained from the audio frequency amplifier arrangement of figure 2 than from figure 1.

A casual inspection of the diagrams given above would indicate that the circuit of figure 1 is the more simple. That this difference is more apparent than real, may be understood from the following.

(a) While the circuit of figure 2 is the one usually employed by amateurs, there is no reason why a much simpler one cannot be used for the same purpose. More than one filament battery and rheostat, and more than one plate battery are not necessary. Circuit diagrams, recently released by government authorities, show as many as five vacuum tubes operated from one A and one B battery.

(b) The transformer T, between the detector and amplifier, is not always necessary and in some cases is of no help at all.

In figure 3 is shown a recent form of cascade amplifier which is simpler than the arrangements usually employed, and which gives excellent results. It will be noted that two batteries, one transformer, and one filament rheostat have been eliminated. A small audio choking iron core inductance has been inserted in the plate circuit of the detector tube. This arrangement is no more complicated than the regenerative circuit of figure 1 and has two less adjustments which will be explained further on.

The regenerative circuit requires a greater number of variable elements than does the amplifier. In addition to the usual primary and secondary tuning condensers and loose coupler adjustment, variable coupling is required between the "tickler" coil T and the loose coupler secondary S, figure 1. A variable condenser is required to by-pass the radio frequency around the telephones and plate battery. In many cases also, it is necessary to provide a means of adjusting the plate potential—see potentiometer of figure 1. It is true that the amplifier of figure 2 or 3 requires two vacuum tubes instead of one as well as a choke coil, but these are easier to provide than the ordinary instruments required for a successful regenerative receiver.

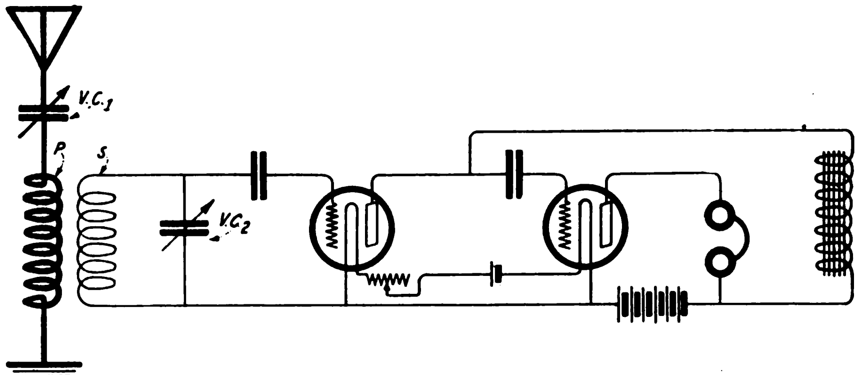


Figure 3—Circuit diagram of the improved form of cascade amplifier

When ease of manipulation is considered, the superiority of the amplifier circuit becomes at once apparent. After the filaments are lighted and suitable plate potentials applied, no further adjustments are required, leaving the operator free to devote all his attention to tuning the primary and secondary circuits and copying the messages. With the regenerative receiver, however, not only are these adjustments necessary but the "back" coupling and the variable bridging condenser VC3 must be regulated. It frequently happens that these two latter adjustments must be repeated if the tuning is changed. For the maintenance of steady oscillations and the prevention of "spilling," it becomes occasionally necessary to adjust the filament temperature and the plate potential. These numerous adjustments are particularly "cranky" at the short wave lengths used by amateurs.

When an oscillating regenerative receiver is used for the reception of damped wave trains, the characteristic tone of the spark note is lost and all signals heard in the head telephones are harsh, hissing sounds irrespective of whether the transmitter employs an open or rotary spark gap or a quenched gap. This not only nullifies the well-known beneficial effects of a high spark frequency, but renders identification of the sender by recognition of his spark note impossible. On the other hand, when a cascade amplifier is used, the detecting action of the first tube is not interfered with and that of the received note is determined solely by the spark (group) frequency of the transmitter, the same as with a mineral detector.

The question of freedom from interference will continue to be of growing importance as the number of stations attempting intercommunication within a given area increases. When it is noted that the oscillating regenerative receiver responds to both damped and undamped waves, while the cascade amplifier receiver responds to damped waves only, it will be apparent that the latter is more free from unwanted signals than the former. Amateurs will find this particularly true since the war, inasmuch as a number of very powerful undamped wave transmitters have been established whose higher harmonics are especially troublesome to short wave oscillating receivers. These difficulties are accentuated by the fact that individual spark transmitters cannot be recognized by their peculiar spark note when an oscillating regenerative receiver is used.

If the apparatus is properly constructed and carefully wired together using stranded rubber covered wire and soldered joints, and if due attention is paid to maintenance of A and B battery voltage, these circuits are equally good from the point of view of reliability.

For the man who makes his own apparatus, the cascade amplifying receiver will probably cost a little more, due to the fact that two audion bulbs must be provided instead of one for the regenerative receiver.

Last but not least, it is to be remembered that the cascade amplifier is not limited to a single step as indicated in figures 2 and 3, but that two or even three additional steps may be attached thus producing enormously amplified signals suitable for the operation of loud speaking devices as used in Signal Corps and Naval operations during the war.

From a thorough consideration of the foregoing factors, particularly those of the signal note, interference, and ease of operation, there is no doubt but that the cascade audio frequency amplifying receiver is to be preferred to the regenerative oscillating receiver for short wave amateur use.

An Unusually Simple Circuit for Long Waves

By Elliott A. White

AN oscillating regenerative circuit of extreme simplicity for the reception of long damped or undamped waves is shown in Figs. 1 and 2. The only variable elements are a variometer V and a feedback condenser C2 (Fig. 1), or a variable inductance L and tuning condenser C1 besides the feedback condenser C2 (Fig. 2). Tuning is done entirely by V or by L and C1, the strength of the feedback being adjusted by C2, for which (with a loss of flexibility) a small fixed condenser may be substituted, though the latter is not recommended. The circuit is very stable in operation. Its lack of sharp tuning is no disadvantage with the long waves, where there is practically no interference. Further stages of amplification may be added by substituting the primary of a second amplifier transformer for the telephone P; but the set is not adapted to give efficient results with more than two stages of amplification. The circuit gives particularly good results with the Signal Corps two-stage audio-frequency amplifier SCR-72, a detector bulb being supplied, the clips marked "Radio" being connected in the detector plate circuit, and the feedback connection being made to the third telephone binding post from the left on the panel.

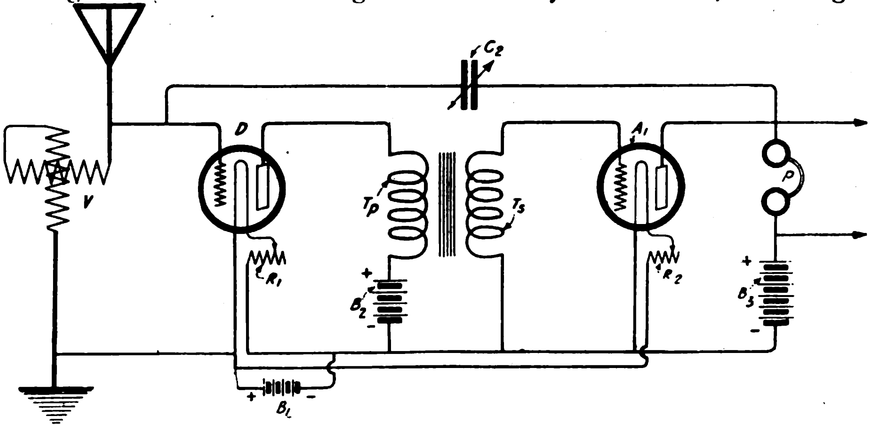


Figure 1—Diagram of an oscillating regenerative circuit containing a variometer and a feed-back condenser

The dimensions of the variable elements are as follows for wavelengths up to the longest (NSS-17000 meters): V-175 to 250 millihenrys maximum inductance, depending on the size of the antenna. L-60 to 125 or 175 millihenrys maximum inductance, depending on the capacity of the antenna. For this the largest or second largest sized honeycomb coil (175 or 125 millihenrys respectively) is generally sufficient, and may conveniently be supplied with three or four taps, at ⅛", ¼", ½" and ¾" from the inside edge, measured on the face of the coil. This practically eliminates adjustment of L, all tuning being done with C1. The Condenser C1 may be of either .0005 or .001 microfarad maximum capacity (17 or 43 plate as usually manufactured). The smaller size of .0005 microfarad is sufficient for C2. It will be noted that the capacity of C1 is added to (in parallel with) that of the antenna to determine the wavelength. The variation of C2 has only a slight effect on the wavelength adjustment. Since, with a given antenna, the sharpness of tuning depends on the resistance of V or L and on the capacitance of C1 compared to the inductance of L, C1 should be kept relatively small and the resistance of V or L kept as low as possible. The tuning may be made still sharper with corresponding increase of L or V by placing a series condenser in the antenna circuit. To reduce induction noises and improve stability a small fixed or variable condenser may be connected in parallel with V in Fig. 1. No detector or amplifier grid condensers or leaks are necessary.

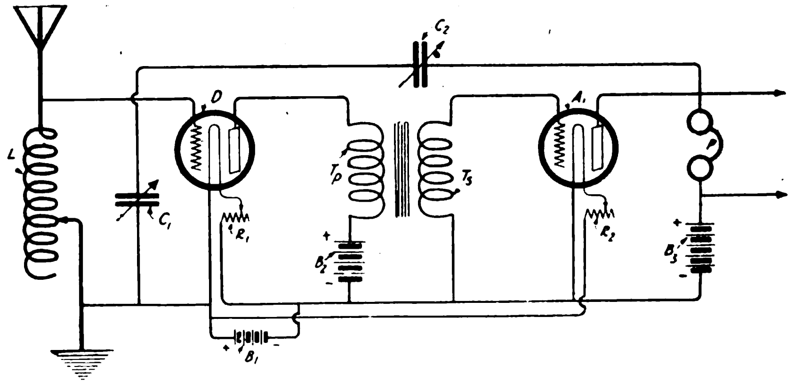


Figure 2—Diagram of an oscillating regenerative circuit containing a variable inductance and a tuning condenser in addition to the feed-back condenser

Outside of these variable elements the rest of the circuit comprises the vacuum tubes D and A1, detector and amplifier respectively, preferably of the high vacuum type (VT-1, VT-11, VT-21, etc., Class II VT). A battery B1 of 4 or 6 volts supplies all the tube filaments in parallel. R1, R2 are the filament rheostats. For the high vacuum type of tube these may be fixed. With a 4-volt battery no filament resistance is necessary for the VT-11; for the VT-1 fixed resistance may be used of 1.05 ohms or a little more for the detector and 1 ohm for the amplifiers. The detector grid is connected to the positive side of B1 and the amplifier grids to the negative side of B1 through V or L and the amplifier transformer secondaries respectively. The plate batteries of 22½ volts or more are indicated at B2, B3. By inserting a condenser in the grid of A1, it is possible to use one set of batteries for the plate circuits, but it is not recommended. B2, B3 may be of fixed voltage. The filaments are grounded.

EXPERIMENTERS' WORLD

Views of readers on subjects and specific problems they would like to have discussed in this department will be appreciated by the Editor

Variometers and Their Construction

By Thos. W. Benson

THE variometer is used extensively at present in regenerative receptors but has received little consideration as to construction details. Invariably they are of the ball secondary or plain tube type. In connection with some experimental work the writer has designed two types of variometers differing from the above. They are described here and are offered on the basis of being more compact, easily constructed and still capable of being built with a large range of wave lengths.

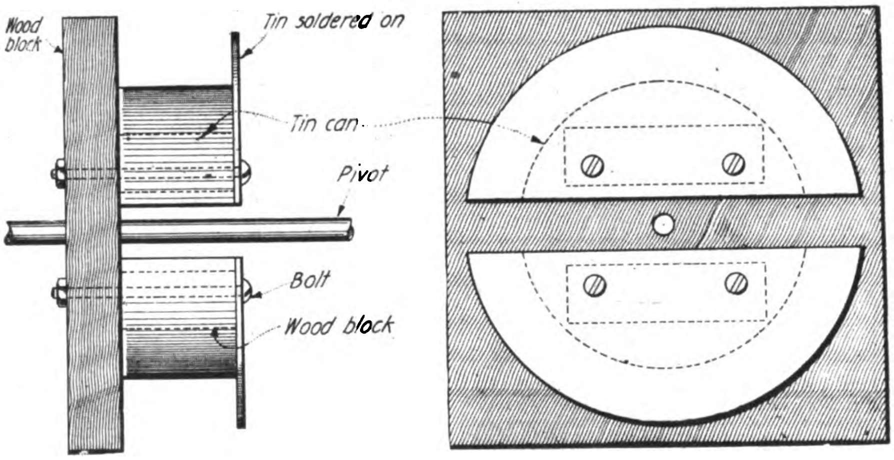


Figure 1—Construction of the form upon which the coils of the variometer are wound

The figure 4 variometer is made on a form shown in Fig. 1. A tin can of the proper diameter, say 4", is cut off to a height of 1½" and then slit in half, removing a strip ½" wide down the sides and across the bottom. A hack saw is best for cutting the corners, shears being used for the flat metal. Each half has soldered to it a semi-circle of tin to form a side ¾" high.

A board 6" square has a ¼" hole drilled in its centre, the can halves being attached to the board by bolts or long screws so the sides of the original can form a circle.

A ¼" rod is fastened to a bench or table and the board pivoted on it. The winding is done in the form of a figure eight, the wire crossing between the halves of the can after each half turn. Banked layers to the amount desired can be rapidly wound by rocking the board back and forth with one hand and guiding the wire into place with the other. For the stationary coil the ends of the wires should come at the outside of one coil. The movable coil should have the leads brought from the center.

When the winding is complete melted paraffin is dropped in several places on the coil to hold it together while the form is being removed. If desired the coil can be taped up and used in its present form, but it can be further improved in point of ruggedness by casting in plaster of Paris.

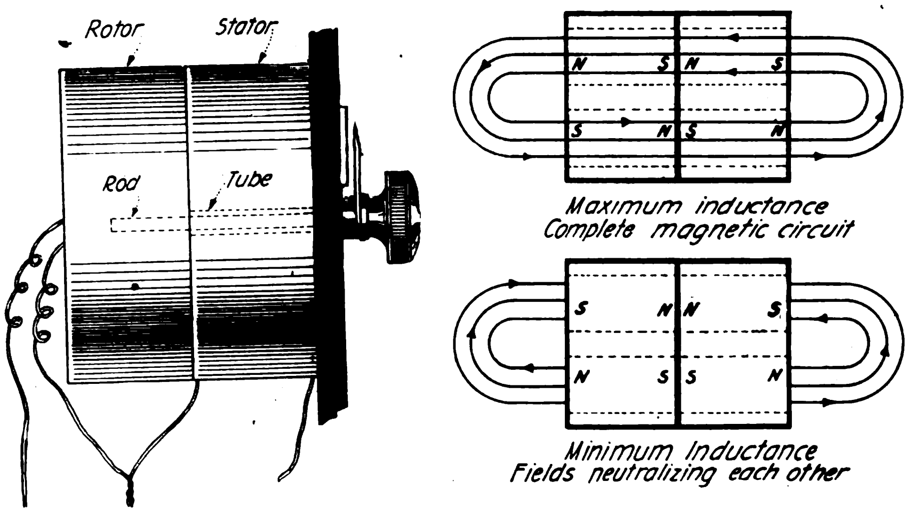


Figure 2—Method of mounting the coils and diagrammatic representation of maximum and minimum inductance

To do this lay the coil on a sheet of glass slightly rubbed over with vaseline. Make a ring of paper or cardboard to fit around the coil and come even with the top. A two inch length of brass tubing with an internal diameter of ⅛" is stood exactly in the centre of the coil. Plaster of Paris is mixed with water to a thick paste and poured into the form. Before the mixture hardens two brass machine screws are inserted so the coil can be mounted on panel. After hardening the cast may be brushed over with melted paraffin to act as a binder and lubricate the rubbing surfaces.

The movable coil is treated in the same manner except that a ⅛" brass rod long enough to reach through the movable coil and the containing case is inserted in the centre to form a means of turning the coil.

The coils are mounted in the case as shown in figure 2, being connected so that the current will flow in the same direction in adjacent halves of the coils when the pointer rests on 180° or maximum inductance. A word as to the theory of operation. Each half of the coil possesses a magnetic field, the two halves of each coil forming a magnetic circuit. In one position the fields of both coils will be in the same direction. Turning the secondary through 180° causes the fields to oppose each other, giving minimum inductance. This is shown diagrammatically in Fig. 2. This type of variometer can also be used as a short wave coupler, a 90° turn varying the coupling from minimum to maximum.

It is extremely rugged, can easily be

built with coils of equal inductance without calculation or experiment and will be found to have a wide range of adjustment.

The second type of variometer is made as shown in Fig. 3. At A is shown the form for the stator made of wood sides and heavy cardboard strips at top and bottom. Slots cut into the wood at the ends of the strips have strips of fiber forced in them to prevent the winding from slipping off. The winding can be done in single or banked layers, the turns being pushed aside at the centre to permit the rod to pass.

The rotor is cut from wood as shown at B and the edges rounded. Here also fibre strips are inserted to hold the wires. The windings on stator and rotor should have equal values of inductance, the usual practice being to wind equal lengths of wire on both.

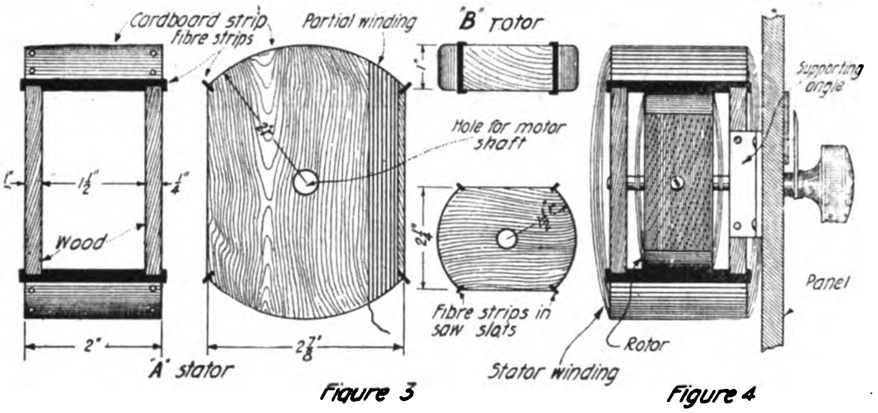


Figure 3—Plan view of the new type of variometer. Figure 4—Variometer mounted

After assembly the rotor is fastened to the shaft by a long brass screw run in from one side. The leads from the rotor are preferably brought through holes in the stator near the shaft after wrapping the wire once or twice around the shaft to allow play. The stator is mounted in the cabinet by two strips of brass attached to the edges with small brass wood screws as shown in the illustration.

This variometer is likewise compact and rugged and still has the windings close together, thus obtaining highest efficiency in operation.

No data as to size of wire, etc., has been given, the object being only to show constructional details. The dimensions given are proportional and by retaining them the constructor has a symmetrical instrument.

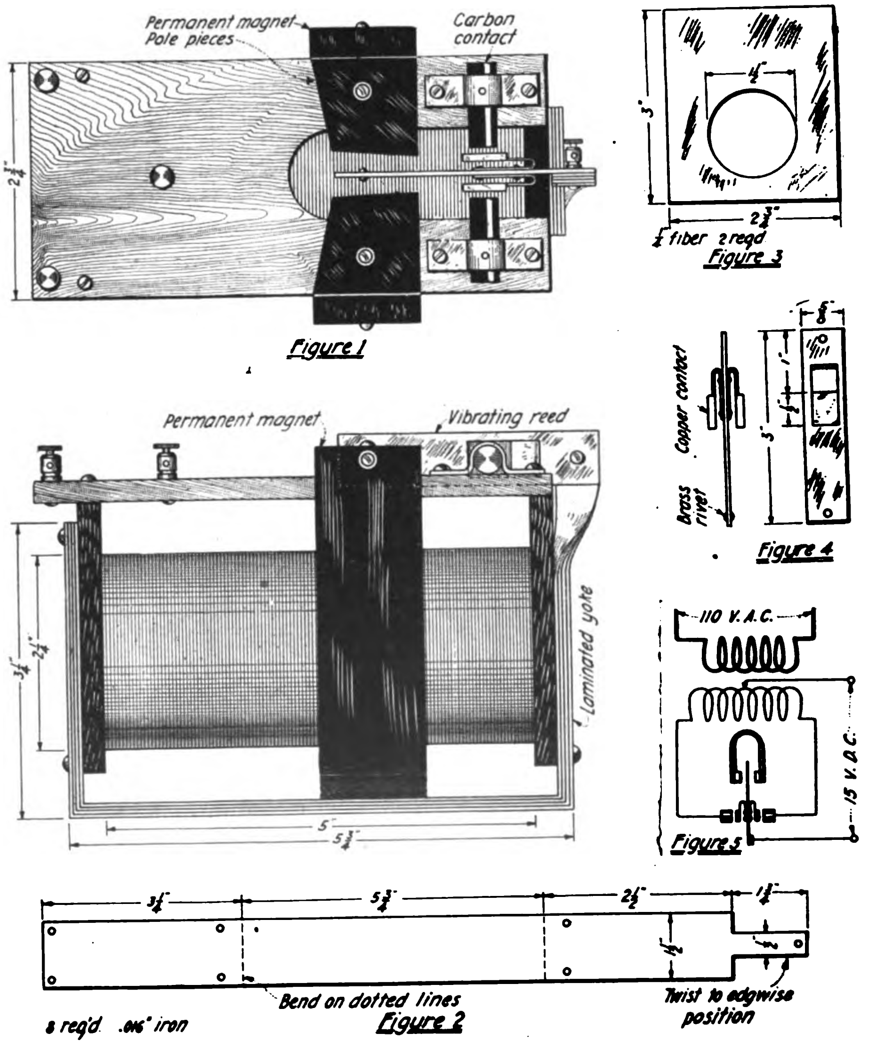
A Small Rectifier for Charging Storage Batteries

By Armo A. Kluge

STORAGE batteries are universally used in amateur radio stations for operating the filaments of vacuum tubes and their upkeep forms one of the greatest items of expense connected with a receiving set. Nearly every station has a source of alternating current supply, however, and by the construction of a small rectifier the batteries can be charged from this source at a trifling cost. This should be of particular interest to amateurs who contemplate the use of multi-stage amplifiers and vacuum tube transmitters which require considerable current.

The rectifier to be described is of the magnetic type having a vibrating reed for changing the connections of the circuit so as to rectify the current. This reed is the weak point of most amateur rectifiers, as it is usually not designed for the frequency at which it must vibrate, while if designed according to principles of physics a most efficient rectifier will be produced. The rectifier here described is designed for operation on 60 cycle supply current, so that the reed must vibrate 120 times per second.

Figure 1 shows a top and side view of the completed instrument. It consists essentially of a small step-down transformer, a permanent U-shaped magnet with two small pole pieces, and a vibrating reed, one end of which is attached to an extension on the core, and the other end is free to vibrate between the poles of the magnet. This reed carries two contacts on opposite sides for alternately mak-



Detailed and assembled views of various parts of the rectifier

ing contact with either of two stationary carbon contacts.

The core for the transformer is composed of a bundle of iron wires assembled in a fiber tube 5½ inches long and 1½ inches outside diameter, with a 1/16 inch wall. Annealed iron stove wire cut to the proper lengths will be satisfactory for this core. After the end pieces and the windings have been put on the core a magnetic yoke is screwed on to the end pieces to complete the magnetic circuit. This yoke is laminated of eight pieces of transformer iron, measured and bent as shown in the detail drawing, figure 2.

The secondary winding consists of two layers of 67 turns each, No. 14 D.C.C. magnet wire. About ½ pound will be required. A tap is brought from the mid-point of the two layers to a binding post on the fiber top, while the ends are connected to the stationary carbon contact posts. The primary winding which is wound over the top of the secondary, consists of four layers (520 turns) of No. 22 D.C.C. magnet wire. About ¾ pound will be necessary. The leads from this winding are brought to two binding posts at the end of the fiber top. The transformer will consume about 100 watts on 115 volts, and will deliver 15 volts, 6 amperes, on the D.C. side. In case a smaller output is desirable, the addition of two layers on the primary, making a total of 780 turns, will give an input of 50 watts and an output of 10 volts, 4 amperes.

Figure 3 shows a detail of the fiber end pieces, made of ¼ inch fiber, and having a 1½ inch hole for the insertion of the core. Figure 4 shows the details of the vibrating reed which can be a piece of clock spring with two small contact springs riveted on the sides. These contact springs carry copper lugs at the ends for the contact faces. The small brass rivet near the free end of the vibrating reed is necessary to prevent the reed sticking to the permanent magnet on contact.

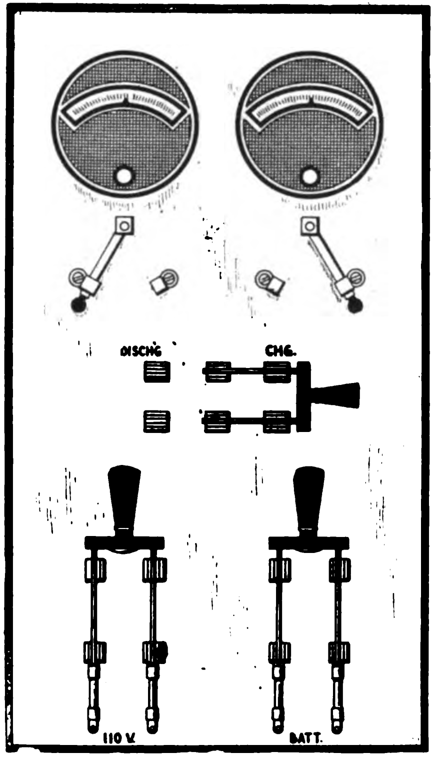


Figure 6—Suggested design for mounting the meters and switches used to connect the rectifier with supply current

The circuit for the rectifier is shown in figure 5. At each reversal of the alternating current the magnetic polarity of the core—and thus of the reed—is changed, and the reed is attracted by the opposite pole of the permanent magnet. This results in a change of the contacts so that the polarity of the output terminals remains the same. This polarity depends upon the position of the permanent magnet and must be determined when the rectifier is first assembled. An easy way to do this is to put the two leads in a glass of water, the one giving off an excess of bubbles being the negative.

In addition to the rectifier, a small ammeter (0-10), a volt-meter (0-8), and a hydrometer should be included in the equipment for charging batteries. A suggested design for mounting the two meters and the necessary switches for permanently connecting the rectifier to the battery and supply current is shown in Figure 6. The small two-point knife switches are for throwing the meters out of circuit, the D.P.D.T. switch for connecting the storage battery to either charge or discharge, and the two fused switches for the supply current and storage battery connections.

A word with regard to the care of batteries. They should be charged every two weeks, even if only an hour's charge is necessary. Distilled water should be added when the solution gets below the top of the plates. While connected to the supply current a three-cell battery will read 7.5 volts when fully charged.

Construction of a Laboratory Transformer

By Thos. W. Benson

THIS transformer will be of interest to those who have occasion to use voltages ranging between 5 and 1000 volts. It will have constant service capacity of 250 watts, which rating can be exceeded for short runs. It may be connected directly to 110 to 220 volt supply mains, requiring no extra inductance or resistance.

The outside dimensions of the core are 6" x 8", the cross section measuring 1½" x 1½". Twelve pounds of iron will be required cut into strips and 1½" x 6½" and 1½" x 3½". Sufficient strips should be cut to make a pile of each size 3" high. Divide each pile into two equal parts, thus getting material for the four legs of the transformer. The longest strips form the winding legs. The strips should be painted with shellac.

To assemble them, provide a device as shown in Fig. 1. Two pieces of wood are mounted 8" apart on the base with a third piece arranged to form a back. Now by putting alternate pieces of core against the ends of the arrangement the core can be quickly built up. After a pile 1½" high is obtained, it should be carefully removed and tightly bound together with friction tape. The other winding leg is built up in the same manner.

Heads are now fitted to the two windings cores. They are cut from ¼" fibre to the size shown in Fig. 2 and slipped over the ends of the cores. The cores are now wound with three layers of empire cloth or paper shellacked into place.

On one leg wind 10 layers of No. 18 D.C.C. wire, tapping at each layer and tagging the leads A, B, C, etc. Each layer should be given a coat of shellac to hold the wire into place. The coil after winding should be placed in an oven to dry thoroughly. Stranded lamp cord in one foot lengths should be used for making taps.

The other leg is first wound with four layers of No. 14 D.C.C. wire (2 lbs.), tapping each layer and tagging the leads 1, 2, 3, etc. This winding is covered with three layers of empire cloth and the fine winding then put on. The latter consists of ten layers of No. 24 D.C.C. wire (1 lb.), which is also tapped at each layer, tagging these leads a, b, c, etc. After thoroughly shellacking this coil it should be baked until dry.

The transformer may then be assembled. Stand the two wound cores on their end and insert the cross pieces of core iron in the slits at the end of the cores as in the usual construction.

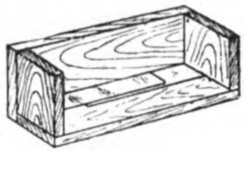


Figure 1

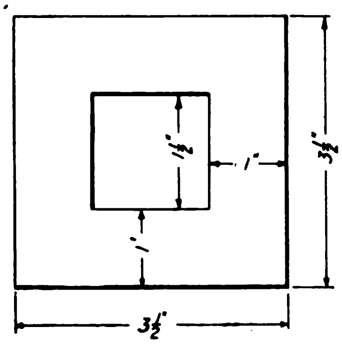


Figure 2

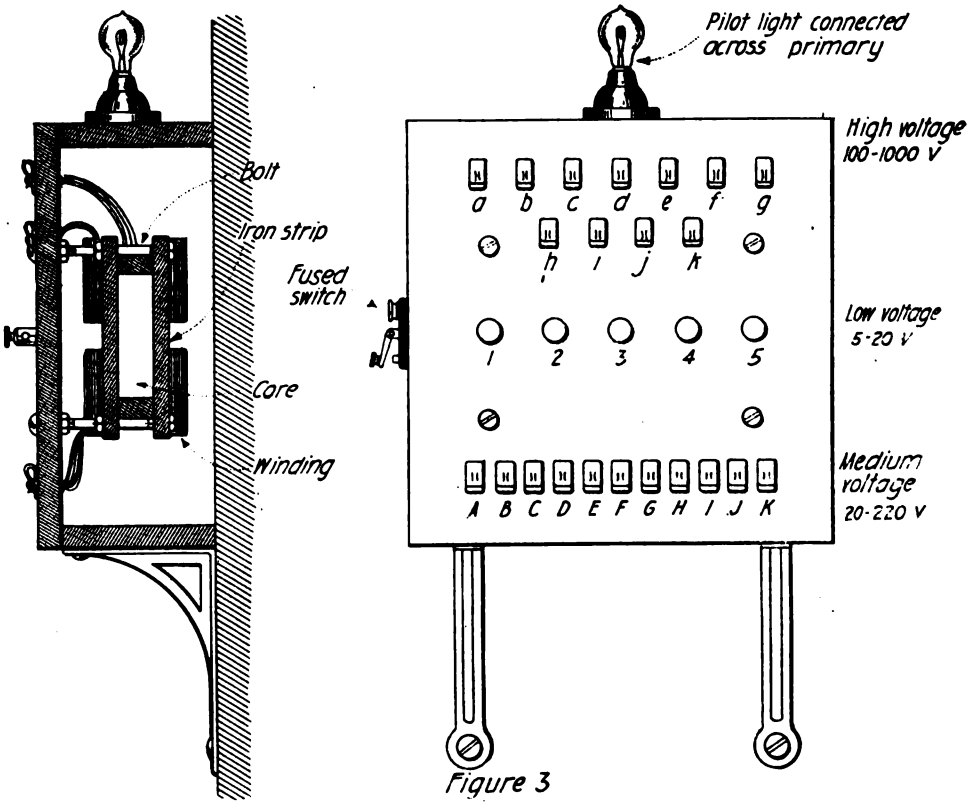


Figure 3

Figure 1—Box for assembling core. **Figure 2**—Dimensions of coil heads. **Figure 3**—Transformer completed showing interior arrangement and method of connecting leads

At Fig. 3 is shown a good method of mounting the transformer in a box on the wall. Bolts are used to support it clear of the box, which should be lined with asbestos and holes cut in the bottom and top to allow the air to circulate.

On one side a fused switch and an indicating lamp is mounted to show when the power is on and thus prevent accidents.

The front of the box has binding posts that are connected to the taps from the coils and marked accordingly. Spring binding posts obtained from old batteries will be suitable, but screw binding posts are preferred for the low voltage connections where heavy currents are drawn.

As to the voltages and how obtained. If the house service is 110 V, connect the leads from the switch to the taps A and F on the No. 18 winding. Should it be 200 V, connect to taps A and K. Between post A and K it is possible to draw from 20 to 220 V in steps of 20. This coil acts as an auto-transformer.

Between posts 1 and 5 the voltage ranges from 5 to 20 in steps of 5 volts. The fine winding will give voltages between 100 and 1,000 V by spanning the proper number of sections in steps of 100 volts.

This transformer will work direct on 60 cycle current; for 25 cycle supply insert a choke coil of the same general dimensions as the No. 18 winding on the transformer proper. On 133 cycle current the rating will be cut down to 125 watts at full load, due to the higher choking effect of the primary in the higher frequency.

It is advisable to put fuses in the primary circuit that will blow if an overload comes in on the transformer. This will effectively prevent damage to the device.

A rheostat may be included in circuit if fine variations of voltage are desired.

Use extreme care with the 1000 V secondary or a nasty shock if not a fatal accident may result.

Construction of Variable Condensers

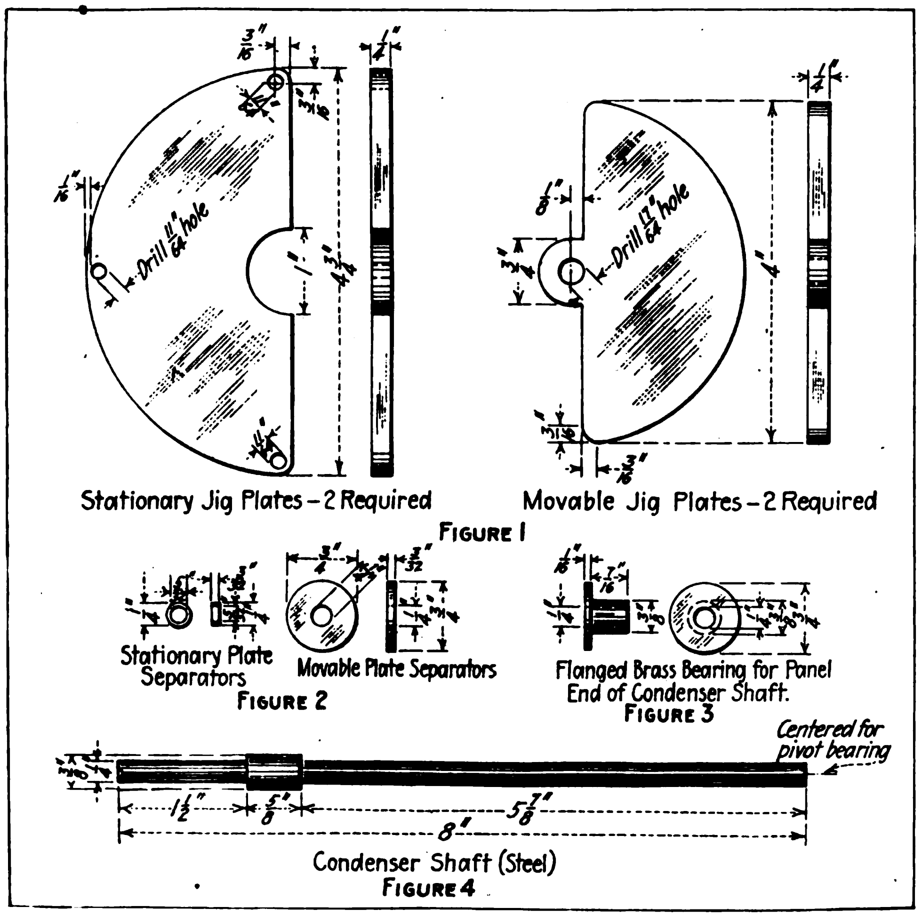
By Ernest G. Underwood

PROBABLY a great many amateurs have made more or less earnest attempts to construct their own variable condensers. In the majority of cases, however, one is apt to give it up as hopeless unless he goes about it in the proper way. The variable condenser is one of those pieces of apparatus which the amateur cannot well be without, but he has been forced in order to provide himself with a condenser which was at all satisfactory, to purchase one of those on the market.

It is the intention of this article to give a few suggestions regarding variable condenser construction which, if followed out, should enable the amateur to build his own variables for his particular purposes.

The three most important parts of a condenser, and the things which are also usually the most difficult for the amateur to construct are the plates, the spacers, and the shaft. The accompanying drawings give dimensions of jigs which were used for making the condensers which I am incorporating in a new receiver now under construction. It is the use of these jigs which makes it possible to uniformly shape the plates in order that, when the condenser is finished, it may be neat in appearance.

The size of these jigs as well as dimensions for all holes, are shown in figure 1. The jig plates were turned from "XX" Grade Steel, and should be not less than ¼" in thickness. These plates were made for me by a machinist, from drawings furnished. He shaped them, bored the holes, and tempered them. Their cost will vary according to the cost of the material and labor, and if several condensers are to be made, the initial cost will be


Drill 11/64" hole
Drill 11/64" hole
Stationary Jig Plates - 2 Required
Movable Jig Plates - 2 Required
FIGURE I
Stationary Plate Separators
Movable Plate Separators
FIGURE 2
Flanged Brass Bearing for Panel End of Condenser Shaft.
FIGURE 3
Centered for pivot bearing
1 1/2"
5/8"
5 7/8"
8"
Condenser Shaft (Steel)
FIGURE 4

Detailed constructional plans for the variable condenser

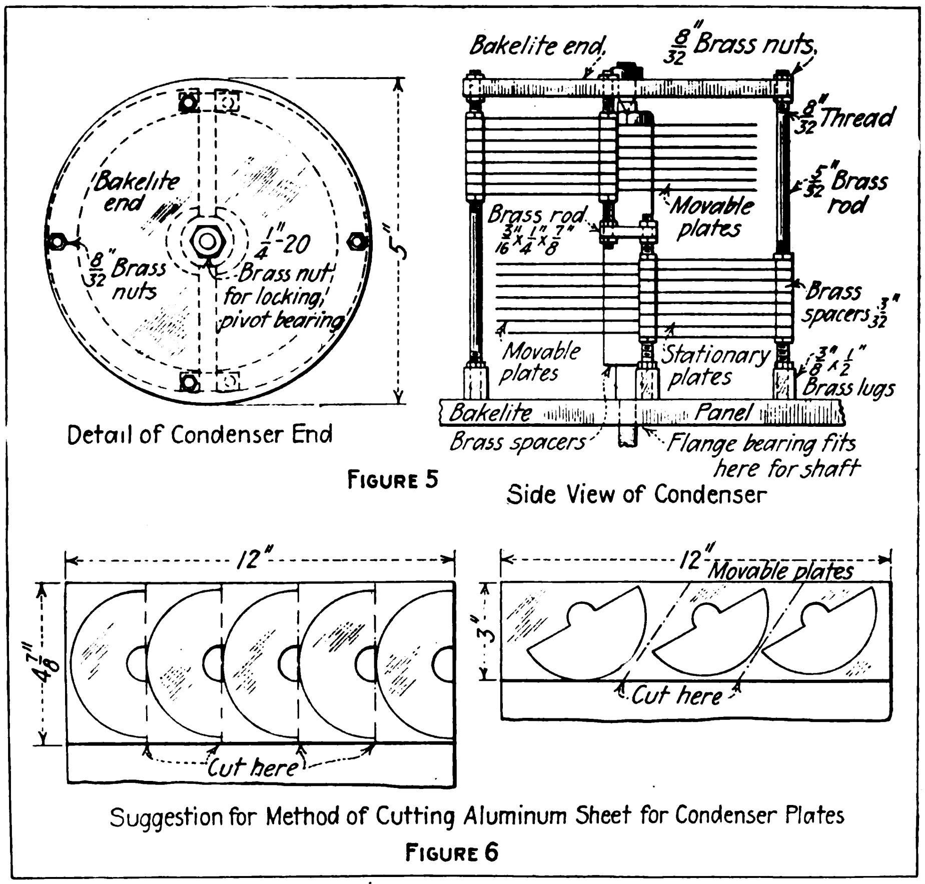
more than compensated for by the money saved, the appearance of the finished condensers, and the pleasure to be derived from their construction.

Attention is called to the fact that the front and inside edge of the movable plates is 1/8" distant from the center of the shaft hole. This spacing is desirable in order that a low zero value of capacity may be had. This distance, of course, may be increased if desired.

No. 20 or 22 gauge sheet aluminum is preferred as the material from which the condenser plates are made. A thinner aluminum bends easily and is harder to keep in shape, thus tending toward short circuits. The use of heavier aluminum simplifies assembly considerably and makes for a more rugged unit. This sheet aluminum comes in 12" widths.

Figure 6 shows the method of cutting and laying out the plates. The aluminum is first cut into pieces of about the proper size for the plates. Three or four of these pieces are clamped between the jig plates in a vise, and the holes bored. If the jig plates have been carefully aligned, the drill in passing from the hole in the front plate into the aluminum, will then pass out through the corresponding hole in the rear plate. A little care will be needed in handling these jigs but it will not be long before it is possible to use them quickly and accurately. It is well to drill all the plates first before attempting to shape them. After drilling has been done, take three or four plates and clamp them between the jigs, using No. 8-32 machine screws as clamping screws for stationary plates, and 1/4-20 machine screws in the case of the movable plates. After the plates have been securely clamped, they are again placed in the vise and as much of the surplus aluminum as possible is cut away with a hack saw. A fairly coarse file is then used to cut them down to the point where the file strikes the hardened steel jigs. After the plates are removed from the jig, the rough edges are taken off with a file and finished with sandpaper. They must then be flattened. This may be done as follows: Place the plates on a perfectly smooth board and tap lightly all over with a wooden hammer if this is available, until they lie perfectly flat.

We will next consider the brass spacers which separate the movable and stationary plates. These washers are shown in figure 2. The small ones are made from 1/4" brass tubing, the large ones from 3/4" round brass rod which has been drilled in the lathe before being cut off. In cutting off these separators, care should be taken to see that they are all exactly the same thickness. It is a rather difficult matter to get these spacers exactly the same size in the average lathe. This difficulty, may be gotten around by cutting off several more than will be required for the particular job in hand, and selecting the ones which are suit-



End and side views of the condenser and method of cutting the plates able for use, with the aid of a micrometer or gauge, or if they run somewhat over-size, they may be ground down one or two thousandths of an inch by rubbing them over a piece of fine emery cloth laid on a flat surface.

The shaft is turned up on a lathe from either steel or brass and is centered for a pivot bearing in one end (see figure 4.) A flange bearing is used for the panel end of the shaft. A gear wheel may be mounted on the large part of the shaft (which also acts as a thrust bearing for the shaft) into which a smaller gear wheel, controlled by a small knob on the front of panel, meshes. This gear reducing arrangement provides a fine adjustment for the condenser, and when used in modern oscillating circuits, is an extremely handy affair.

Figure 3 shows the flanged brass bearing used on the panel end of the condenser and against which the enlarged portion of the condenser shaft thrusts.

The assembly in figure 5 shows a balanced type of condenser with which no counterweights or friction bearings are needed. Such a condenser will always hold its adjustment. The bakelite end which holds the pivot bearing is also shown in this figure as well as the arrangement of tie rods. These tie rods are of 5/32" round brass and may be threaded 8-32. Care must be taken to make sure that the holes in panels are in perfect agreement with each other as well as with the holes in the plates; otherwise, the condenser will not properly line up and the shaft will bind. The use of a little care in laying out these pieces will prevent any such thing as that.

Finally, a connection is brought off from the movable plates by means of a flexible bronze ribbon fastened to the hub of the gear wheel or to the shaft and after having been wrapped around the shaft two or three times, terminated at a stud fixed in the panel. A stop must also be provided either in the condenser itself or on the front panel after knob and pointer have been attached, to prevent the movable plates from making a complete revolution.

These suggestions should help those who desire to construct their own variable condensers. Condensers of any size and plates of any shape may be made in this way, and the plates may always be depended upon to line up nicely when finished.

A Receiver-Transmitter

By C. C. Henderson

THIS is for the amateurs who use the heterodyne hook-ups for receiving.

I have assumed that we all know that when an audion is in the oscillating state a continuous or undamped wave is set up (generated), the characteristics of which are similar to the wave sent out by an arc transmitting station.

An oscillating circuit consists of an inductance and capacitance and this is just what we have in our receiving sets. Tune the receiver to say six hundred meters. Make sure set is oscillating. The result is that a six hundred meter undamped wave will be radiated from the antenna which—provided perfect resonance has been obtained in the receiving circuits—can be heard by another station several miles distant. The length of this wave is changed simply by tuning the receiver to any desired wave. Most operators know the approximate instrument setting of their receivers for any desired value. For those who are always changing hook-ups; resonance can be obtained by overloading bulb filament until a low hum is heard in the phones; next tune primary and secondary circuits until this note "clears up" and maximum strength of phone signals is obtained.

I have had good results on both sending and receiving with wave lengths from 124 meters up to about 8500 meters. Above this value the oscillations become feeble and good results can hardly be looked for.

There are several ways of breaking the generated wave up so as to enable the operator to form code characters. The hook-up shown in the accompanying diagram will give best results however, as it eliminates entirely any compensating or back wave. "A" is an ordinary telegraph key and shunted around the key is a small single pole, single throw switch, "B" which is opened only when operator desires to transmit on receiving "transmitter."

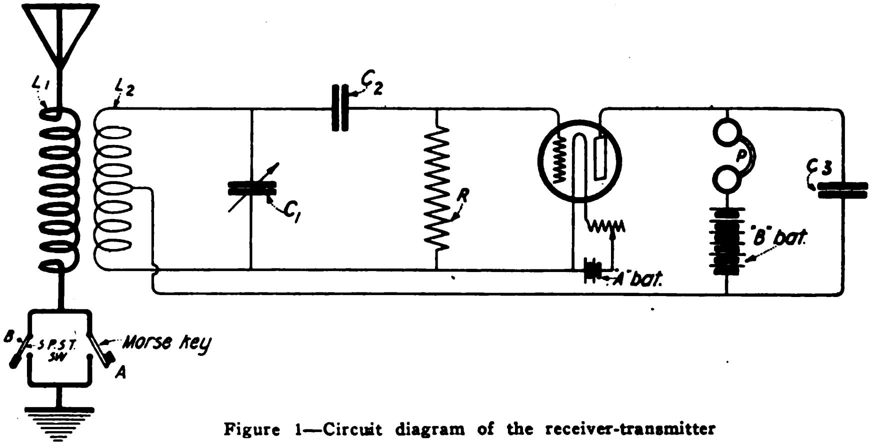


Figure 1—Circuit diagram of the receiver-transmitter

I was on one of the American battleships that formed a unit of the British Grand Fleet during the last thirteen months of the war. Up to the time of our departure for the other side almost every ship in the American Navy was relying on crystal detector reception for all ordinary work. We finally arrived at our base in the North Sea and discovered that Galena and other detector crystals were not going to do the work, so audion reception was started. All ships had to listen in on the same wave-length and this caused the trouble. Using a heterodyne hook-up we could hear innumerable high pitched notes in the receiving phones at all times. Another operator and myself started to ponder over the mystery. I found that by touching some bared portion of the receiver the receiving note was broken. After several days of experimenting communication was established with the battleship New York and a week later the five ships of the American squadron were having a gay old time. But, of course, every good thing has a climax and ours came with a rush. The British operators copied our stuff but they were not in on the secret. I believe a few uncomplimentary remarks were passed about British operators and one of the British flagships managed to collect some convicting evidence. Result was that several senior operators (including myself) were treated to five days solitary confinement in ship's brig for "unauthorized radio communication." It might be noted in conclusion that Admiral Beatty, British Commander-in-Chief, ordered a two day test on "receiving transmitter" work shortly after the "martyrs" to the cause had been released from confinement. Far be it from me to expect any "laurels" for the Yankee "achievement." Due credit must be given to J. McGarry, U. S. S. Florida, and an unknown operator on the New York. I also wish to extend my heartiest congratulations to the British operator who managed to get the "goods" on us. Why? Because we were never able to locate him. Probably "sunk without a trace."

Amateurs On the Job

By Maurice Henle

A FEW short months ago occurred a little drama in the town of Greenville, Ohio, represented by a tiny dot on the map and situated not so far from Cincinnati. Belasco would probably not pause to witness it; nor would Maeterlinck; but it was a drama nevertheless, a real drama.

At a number on West Main Street a youth mounted the stairs to his room. The sun had long since disappeared from view beneath the horizon, and the mystery of the night was abroad. It was one of those nights that make the youthful American mind wander and wonder what is happening away out in the big world, the world into which he hears going those shrieking far-off moanings of the rushing locomotive. He mounted the stairs and closed the doors.

He placed the phones about his ears, threw in his aerial switch and tuned his coupler. A few buzzes; the weather report; he tuned again; the baseball score; the time—

He had now tuned down to about 200-meter wave length, and...

"Hellooo....."

He heard it as distinctly as if his own voice had uttered it. But he hadn't spoken and neither had anyone else in that room or that house. It had come from those receivers so snugly entwined about his head. It was a voice from out the darkness through the greatest annihilator of time and space!

C. H. Katzenberger, now only 19, who was thus thrilled with this revelation of wireless telephony, since has come to Cincinnati to attend a technical school. He lives at the Central Y. M. C. A. and there has installed another wireless set, for he says now his life is not complete without one.

He built the aerial upon the "Y" roof with the permission of officials and strung the wires himself to his room, No. 601. He has received from Key West, Portland, Arlington, and many other far-off places.

* * *

"And it shall come to pass in the year 1919 A. D. that there shall aris a powerful organization to which everyone of the more than 250 amateur wireless operators in and around Cincinnati will belong; which shall hold regular meetings to which all members may attend and discuss problems of wireless which arise so that all may benefit; that there shall be a cozy clubroom with comfortable chairs and plenty of magazines where all may drop in and chat and meet their fellow operators; so that they may thus profit in wireless and communication!"

Dorman Israel, prominent wireless amateur in Cincinnati

No, patient reader, with your mind teeming with vacuum tubes, and aerials, and detectors, and loose couplers, and antennas, and one hundred and one of the vitals of wireless—this is not a parody on the Book of Books. It is a page of the unwritten Bible of the amateur wireless operator, a lore which has been learned by heart by every earnest devotee of the greatest of indoor sports, not even excepting African golf, spooning, and billiards.

Wanted: A wireless club!

Wanted! And badly wanted. It is this lack of co-ordination, and only this lack of co-ordination which is retarding the Cincinnati amateur wireless operator, and holding him back from better things. It is this lack of co-ordination and unification which made amateur wireless operating at times so miserable a pursuit, especially before the war. For the amateur who cannot send properly is a meddlesome beggar; and that is one strong reason why a club of operators is imperative.

The plan in the minds of most amateurs is to have a sort of Congress, with an upper and a lower house. In the upper branch would belong only licensed operators. They would be the more skilled; those with better equipment, and surely with a better understanding of the code and instruments in general. In the lower house would belong that great army of unlicensed operators—those who receive only and do not send.

And the two bodies, members of the one club, would meet in separate session and discuss the problems of their respective worlds. The little difficulties which arise would be ironed out, not only to the satisfaction of the operator who is perplexed, but for the benefit of the entire membership as well, which also might be puzzled with those same problems at some future time.

As soon as a member of the lower house is proficient and acquires an operating license, he would automatically leave that branch and be enrolled on the roster of the upper house, where he would immediately be thrown into contact with fellows who have had more experience and from whose gossip and debates he could obviously profit.

And not only does he want a place where he may gather with his fellows, but he also wants competent instructors from whom he may learn the latest in what he considers far more important than meals.

That is what is wanted in Cincinnati. And that is what is utterly lacking.

There can be just a certain amount

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of straining at the leash before the bonds will burst. The strong man will make his muscles bulge, his face grow purple, but it is just that last scintilla of effort under which the encircling ties will snap.

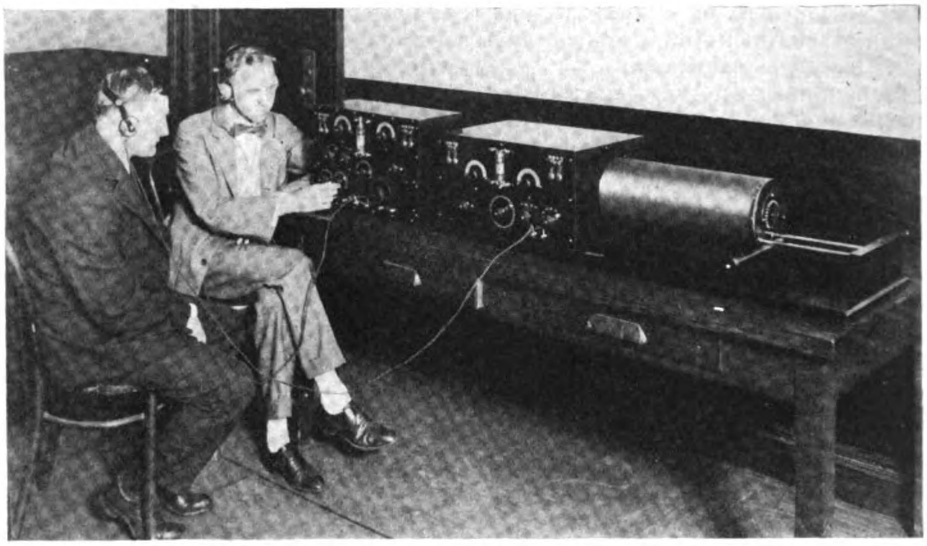
And so it is with the wireless situation in Cincinnati. The old laws of supply and demand hold good. And as the club is wanted, so have rumors and even more than rumors been radiated through the air waves.

Let us go back two years or more. Amateur wireless was gaining a strong foothold in the Ohio valley. More and more young men were buying instruments. The Ohio Valley Wireless Association had been organized and had "flivvered" for lack of members and executives. Over at Hughes High School a wireless club had been formed for students of the school who owned wireless sets at home. And a complete outfit was set up at the school, so that keen interest was being displayed by the students. Then came the war.

Immediately, of course, the government tabooed wireless in Cincinnati and the country. Seals were placed on the sets with heavy penalties attached for breaking them. The aerials were brought down and stowed away in the garrets to be kept there until the Germans signed on the dotted line.

But above all these activities, one effort stood out as pre-eminent. The Union Central Life Insurance Company which owns a skyscraper in Cincinnati, second in beauty and height only to buildings in New York, conceived the idea of building an amateur station. The outfit was to be installed in their building, and at the same time a Wireless Club would be formed for the amateurs in and around Cincinnati in order to stimulate and develop interest in wireless telegraphy. The company planned to have men who understood wireless telegraphy give lectures and practical demonstrations, just as the amateur would wish it. But the war stopped all of it.

Now, the ban has been lifted, for since the 15th of April last, amateurs have been permitted to break the seals of their instruments and receive messages, and with the lifting of the ban on transmitting on Oct. 1, activity by the Union Central company was again renewed. On the very day of the lifting of the ban, the aerial was brought out and extended from the eighteenth to the thirty-fourth floor at a ninety degree slant, the tap for the lead-in being brought into the thirtieth floor where the station is located.


Wireless apparatus used by the Union Central Wireless Club

The coming to Cincinnati recently of a Captain J. P. Gray, of the United States Coast Guard Service, to make a preliminary survey of possible locations for a government wireless station for use by the army, the weather bureau, and other governmental departments, was the signal on the part of the management of the building and W. C. Winall, chief electrician, to endeavor to have that place designated as a government station.

The federal authorities contemplate establishing five or six stations in the Ohio Valley and to equip many government boats on the Ohio river in case of floods, or other emergencies. Captain Gray has recommended the Union Central Building, Hughes High School, the federal building, and several others.

And—to digress—Winall, after telling of a letter he sent to Captain Gray urging designation of the Union Central Life Insurance outfit as a government station, reveals one of the most interesting sidelights of the great part Cincinnati played in the war, and the part wireless came near performing.

Rumors had been flying thick and fast that radicals planned to blow up

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The amateur is told how to measure the inductance, capacitance and resistance of his aerial, how to check up the efficiency of his station. Construction of quench-gap transmitters, methods of measuring the internal impedance and amplification of constant of vacuum tubes are explained.

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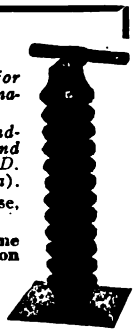


not only the telephone building, but the telegraph companies as well, with the object thus of severing Cincinnati from the outside world. As soon as the rumors had been definitely traced and some truth to them found, steps were taken immediately to stave off a possible attack by the radicals, and to fortify the city if such a move were made. The Western Union was ready to remove its offices in an instant, and complete trunk lines could have been connected immediately, if the main ones had been blown up. Not only this, but Winall urged the navy officials to consider the wireless station, then dismantled, at the disposal of the government, saying that it could be put in operation in twenty-four hours.

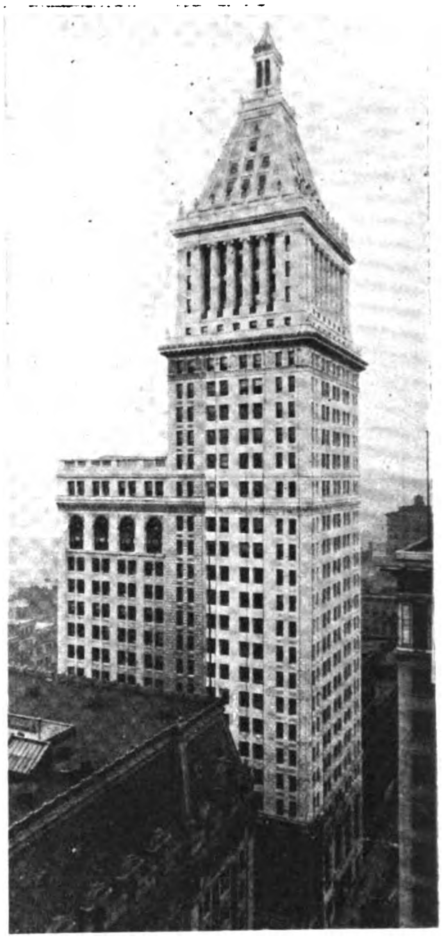
Throughout these uncertain times there remained with Winall a man who had helped him put up the set, Ira Holden by name. He and Aaron Hubbell were pioneers in wireless operating in Cincinnati, having set up the very first instrument ten years ago, which since has multiplied until hundreds of them bind a band of unseen ears about the city. The training Hubbell received, by the way, stood him in good stead in the war, for eighteen months he served in France as an aviation wireless tester.

But to return, the idea of the Union Central Life Insurance Company establishing a Wireless Club has not been abandoned; on the other hand it has been strengthened; but until the ban on sending is lifted, nothing will be done to organize it.

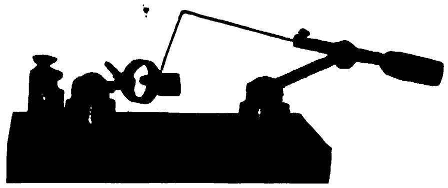
The spark and arc receiving sets with a temporary aerial have been put up with good results; messages have been received since April 15th from the following stations:

Arlington, Charleston, Great Lakes, Pensacola, New Orleans, Cuba, San Diego, Cal., New Brunswick, Annapolis.

The lowest points of the permanent aerial will be not less than 250 feet above the ground and the upper will be about 485 feet above the ground. This aerial will not be vertical but will be offset about 100 feet. It will be composed of phosphor bronze stranded wire. The sending set is to be a 500 cycle equipment, 20,000 volt.



The building in Cincinnati which has an antenna strung from the eighteenth to the thirty-fourth floor



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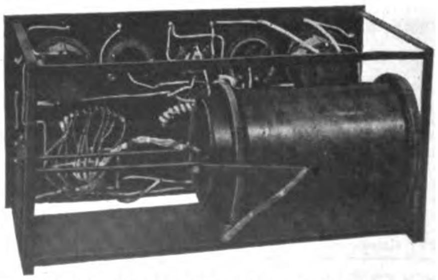

We reproduce the set in its entirety that you may see and understand its construction, instead of enclosing it in a Cabinet and allowing you to guess. It is now used in Schools of Radio instruction where Technical and satisfactory results are necessary.

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1 kw. power. They have a powerful transformer and motor generator. As yet, the company has not purchased a quenched spark gap, which is the only article needed.

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* * *

Red-blooded Americans, who helped lick the Boche with their knowledge of dots and dashes, are coming back, and with them come weird and bizarre tales of adventure. And they have brought back new ways of wireless which they will put to use in their private operation of wireless. For wireless is the one thing which is all mighty to the fiery minds of the red-blooded Americans.

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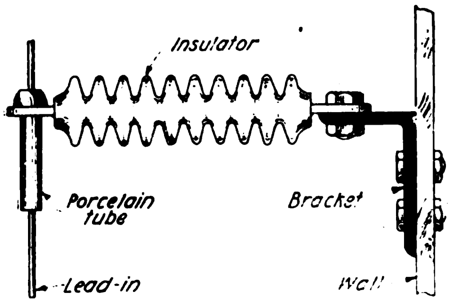
Lead-in Construction

By Henry Klaus

MANY amateurs, especially in cities, are compelled to put their aerials on buildings and the lead-in must be kept clear of everything. The accompanying sketch suggests an inexpensive but efficient way to insulate the lead-in from the building.



Constructional view of lead-in

A common electrose strain insulator is bolted to a bracket fastened to the building and a porcelain tube put through the other eye and the lead-in is brought through this tube. Two or three of these will hold the wire firmly.

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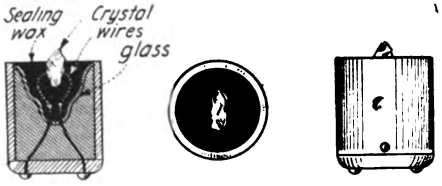
Sealed Detector

By L. B. Salt

THE accompanying sketch shows a very good sealed detector which I made about a month ago, and which, as far as I can see, is as sensitive today as when it was made.



Details of the sealed in detector

The main holder is the base of an automobile lamp. The glass was broken away level with the top of the base and the two wires bent in such a way that a thin piece of crystal could be inserted between them. A test buzzer was used to find the sensitive part of the crystal, and a small piece of sealing wax was melted into the base to hold the crystal and lower part of the wires. Then more wax was put in until it was level with the top of the base. The test buzzer was kept going all the time to be sure that the crystal did not move while putting in the wax.

The wax which I used was taken from the top of a flash-light battery.

The socket into which the base fits can be bought at any automobile supply house for a very little, and burned out lamps can probably be picked up at any garage for nothing.

Several of these detectors can be made up of different crystals, and any one of them inserted in the set in a second.

If one desires to cover the crystal completely, different color sealing wax should be used to designate a certain kind of crystal.

This detector makes a neat looking one on a set, and is small and rugged for a portable set.

Prize Contest Announcement

The strike of the printers, which placed this magazine eleven weeks behind its scheduled publication date, so multiplied the difficulties with the prize contests that no manuscripts have been received on several of the selected subjects. It is clear that the situation is entirely due to the unexpected series of printing delays. For example, the closing date for the March issue contest was set at February 14th, whereas the magazine was not delivered to readers until this date had gone by. Similarly, February 29th, as the closing date for contests originally announced for the November and December issues, did not provide ample opportunity for contestants to send in their manuscripts.

These contests are run for the benefit of our readers, to provide them with funds to continue their experiments. It, therefore, seems fair to all to make the following new offer:

The subject for the April issue will be:
"Mast Construction for the Average Amateur"
Closing date March 17th.

The subject for the May issue will be
"Design and Construction of a Low Power Transmitter for Local Use"
Closing date April 3rd.

Contestants for the prizes are requested to submit articles on either of these subjects, or both of them, at the earliest practicable date. An additional contest subject will be announced in the March issue.

PRIZE CONTEST CONDITIONS—Manuscripts on the subjects announced above are judged by the Editors of The Wireless Age from the viewpoint of the ingeniousness of the idea presented, its practicability and general utility, originality, and clearness in the description. Literary ability is not needed, but neatness in manuscript and drawing is taken into account. Finished drawings are not required, sketches will do. The contest is open to everybody. The closing date is given in the above announcement. The Wireless Age will award the following prizes: First Prize, $10.00; Second Prize, $5.00; Third Prize, $3.00; *in addition to the regular space rates paid for technical articles.*

All manuscripts should be addressed to the Contest Editor of The Wireless Age.

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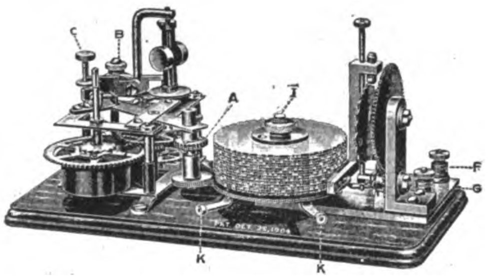

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An Indoor Loop Antenna

By L. W. Van Glyck

ALTHOUGH the simple antenna herein described is now quite common it is seldom used by experimenters in general. This antenna possesses both advantages and disadvantages when compared with the usual amateur type. It possesses the advantage of picking up less static. It is portable, compact, and easily constructed at a much lower cost than the elevated type. It is highly directive, receiving best from stations lying in its plane, and practically not at all from stations at right angles to its plane. If it is turned so that its plane is parallel to the surface of the earth it receives equally well from all directions. On the other hand the antenna herewith described will not pick up as much energy from the transmitting station as the average out-door antenna, but what does that matter in this age of vacuum tube amplifiers?

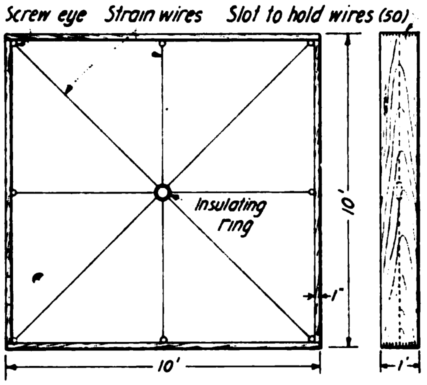

Figure 1—Construction of the insulating ring

The frame is constructed of any soft, light wood, such as basswood. It is wound with 60 turns of No. 20 or No. 22, single silk covered wire, the wire running through the slots in the corners of the frame. These slots may be made with a fine toothed saw. The two ends of the wire are brought to binding posts in the frame at any convenient point and connected to the loose coupler as shown in figure 2. The method of connections is optional, but I have found the hook-up as shown to work very well. It is advisable to use a one-step amplifier for distances over two or three hundred miles.

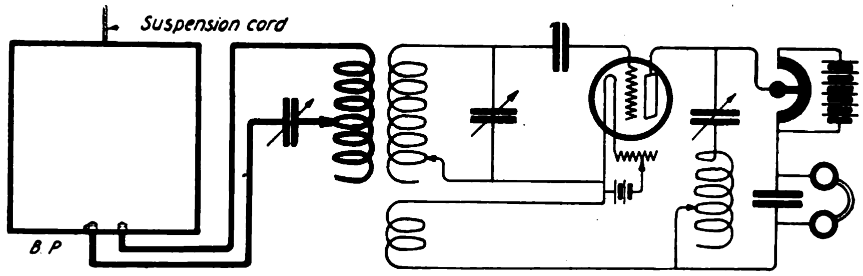

Figure 2—Diagram showing the binding posts and connection to the loose coupler

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Ambitious Program for Bayonne

PLANS for one of the most powerful amateur radio telephone sets ever erected in the Atlantic seaboard section of the country are being considered by members of the Peninsula Radio Club, 17 West 31st Street, Bayonne, N. J.

The club has installed a receiving set of the latest type obtainable; an efficient amplifying set also has been installed.

Members of the club are desirous of interesting Jersey City wireless "fans" in their work, and Secretary Oliver, in behalf of the club, extends to all Jersey City amateurs an invitation to communicate with him and to visit the clubhouse and inspect the plant. It is hoped that some of the Jersey City enthusiasts will join the local organization. Especially is it desired that young men who have never taken an active part in wireless experiments interest themselves in the meetings of the club, which take place each Monday night. At each meeting experiments are made with different types of bulbs and code is practiced.

New Facilities for Amateurs

LOUIS G. PACENT, well known to New York amateurs, has organized an electrical company, through which he expects to serve amateurs to "a greater extent and in a better way than ever before."

Mr. Pacent spent the past ten years with the Manhattan Electrical Supply Company, in charge of their radio departments and all their radio activities.

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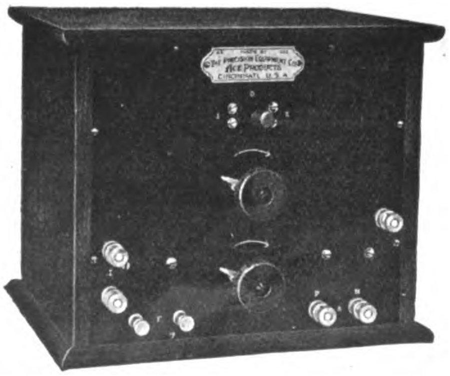

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Radio Intelligence Post of the Legion

THAT wireless men will stick together in peace time and keep alive the friendships which grew out of association in the war was demonstrated in the enthusiastic meeting of the Radio Intelligence Post of the American Legion, held at the Berkley Hotel, New York City, on February 3. An unusually entertaining evening was enjoyed and a very attractive program was outlined for the future. The Secretary is eager to communicate with men who served in the Radio Branch of the Military Intelligence Division, both overseas and in the U. S. The Secretary is Arthur L. Bernhard, 1679 42nd Street, Brooklyn, N. Y.

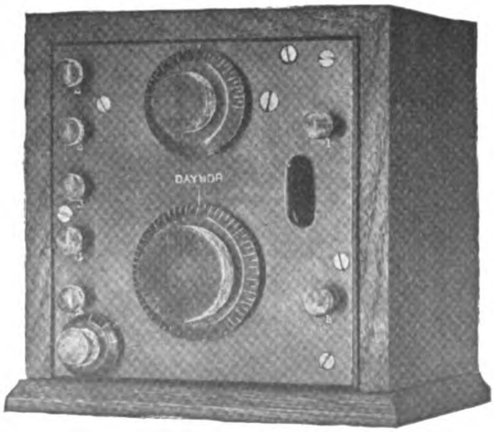
The style of this wireless set indicates in a manner the high type of the present-day wireless amateur

Marconi Expresses Gratitude

T. COMMERFORD MARTIN, chairman of the electrical committee which is raising, in honor of Marconi, a special fund for the Italian War Relief Fund of America, has received a very interesting letter from the distinguished president of our association.

"I cannot tell you how deeply touched I am at this unexpected proof of the sympathy of the American people for my country," Mr. Marconi says, "nor how greatly honored I feel that my American friends should wish to associate my name with a praiseworthy and noble object. Please allow me to express to you and to all who have contributed to this scheme for a special fund, my sincerest and most heartfelt gratitude.

"With regard to the sum of $2,500 which you state is immediately avail-



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able, you may send it to me and I will arrange for its distribution in Italy."

Mr. Marconi added heartfelt thanks "for the great honor which you and all other American friends have done me."

As previously stated in these columns, each subscription is accompanied by an autograph card, with the object of assembling all these cards later in a memorial album to be delivered to Mr. Marconi. Such cards can be obtained from the Committee at 29 West 39th Street, New York City.

"Y" Courses for Ex-Service Men

Ex-service military and naval men, many of whom spent their last months overseas in taking up their educational work, are to have their opportunities continued at home in plants already well equipped and most readily adjusted to suit the needs of soldiers. The facilities of the Young Men's Christian Association and its complete organization in all parts of the country will be at their command for practical education, through free scholarships, as soon as local arrangements in the various cities can be completed.

The army's responsibility for educating the uninjured soldier ceased as soon as the red chevron appeared on his sleeve; but his need for training did not vanish in civilian life. Thousands of men who were interrupted in their life plans by enlistment in the Service, as well as hundreds engaged in the war industries, need further educational opportunities.

These are among the reasons which led to the decision to continue the educational service of the camp and cantonment. The cooperation of nearly two thousand Associations in the United States makes possible the completion of these plans. The enterprise, which will interest thousands of men in these groups, enlarges and extends the educational opportunity of many communities, and by its extension division reaches out to thousands of communities where no Young Men's Christian Associations exist. In addition, in a more limited way, it opens the portals of technical and collegiate instruction to young men properly qualified.

It is the aim of the United Young Men's Christian Association Schools to give the ex-service man just what he most needs, whether it be a short course initiating him into a new occupation, or a longer day or evening course preparing him for more technical efficiency. Because many will feel that they cannot go away to study, or give time during the day, the Association Schools will offer most of their courses at night in the cities where the students live.

For the correspondence courses, of which there is great need, the work will be conducted from one center.

Among the courses (correspondence or resident) that will be of direct interest to Wireless Age readers are:

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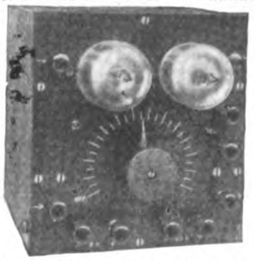

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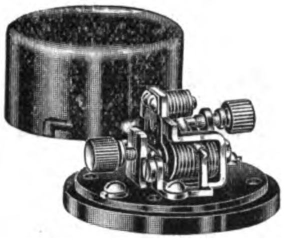

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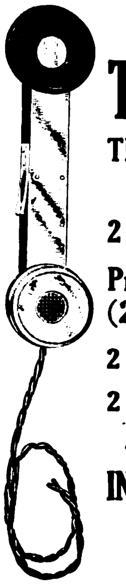

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* * *

H. S. B., Huntington, N. Y.

Reference to the use of closed loops for reception of radio messages was made in June, July, and September issues of the Wireless Age. Further articles in this connection will appear at an early date.

* * *

J. P. S., Buffalo, N. Y.

For the construction of a condenser suitable for use with a 1½" spark coil, you are referred to articles which will be printed in early issues of this magazine. We are unable to give you the inductance value of your antenna but its fundamental wavelength is somewhere in the neighborhood of 230 meters. For the construction of an oscillation transformer for 200 meter work, we refer you to prize articles printed in recent issues.

* * *

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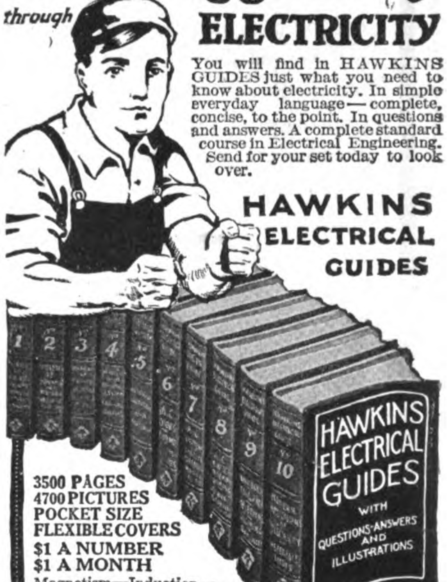

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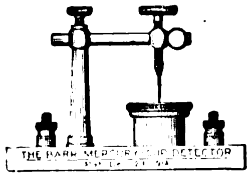

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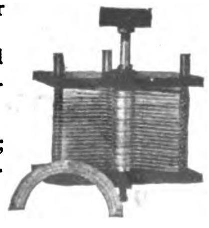

Knocked down variable condensers.

43 plate—.001 MF—$2.75; 21 plate—.0005 MF—$2.25; 11 plate grid variable—$1.75. Assemble and save money.

TRESCO, Davenport, Iowa

J. R., New York City.

A license of any sort is not required for the operation of a receiving outfit.

* * *

G. N. G., East Orange, N. J.

As far as we know, there are no loose couplers on the market having a maximum wavelength range of 300 meters. From what you say we gather that you are after a super-sensitive and extremely selective receiver for amateur wavelengths. The construction of receivers of this type has been described in recent issues of this magazine, or such a receiver may be purchased.

In the construction of a vacuum tube the amount of energy which any vacuum tube will furnish depends entirely upon the value of energy put into that tube. The problem then resolves itself into a problem of designing a tube which will stand high voltages and high currents. Power is measured in watts, not in amperes and the power is the product of the current and the voltage. With regard to the use of vacuum tubes for receiving work, the spacing of the elements is not the only consideration. The degree of vacuum has a great deal to do with the value of plate voltage required to bring the tube into sensitive condition. The audiotron is a tube of low vacuum, whereas the Marconi V T and the Westinghouse tubes have been thoroughly exhausted.

For a discussion of damped and undamped waves, we refer you to "Practical Wireless Telegraphy" by E. E. Bucher (Wireless Press, Inc., N. Y. C.). You will also be able to find in this text book a discussion of the oscillating audion.

As you will learn after referring to the above mentioned book, damped waves are emitted in groups at an audible frequency. The frequency of the waves themselves, however, is so high as to be inaudible. It is apparent, therefore, that if we wish to superimpose impulses at speech frequencies upon an electro-magnetic wave, we should choose that wave which on its own account produces no audible frequency at the receiving station, for, otherwise, the sound produced due to the discontinuity of the wave itself would interfere with the sound produced by the voice modulation.

The induction-like noise to which your receiving set has been subject is, we gather, due in all probability to the fact that somewhere in your vicinity a high tension line is discharging to the branch of a tree or to the earth, due to faulty insulation at some point. If, as you say, you are able to get it with the aerial disconnected entirely, it is probably nearby. If you can rig up a few turns of wire on a loop 2 or 3 feet square and arrange your receiving set so that it is portable, it will be possible for you to follow the electric light lines in your neighborhood and locate this discharge merely by moving always in that direction in which the strength of the signal increases. Upon locating the fault, if you will point it out to the Public Service people, they will, no doubt, remedy the matter. This procedure has been followed in many cases by amateurs.

* * *

H. T., Presto, S. D.

Probably the interference which you experience is due to the discharge of lightning arresters at the power station. Your proximity to this station is unfortunate. You will probably be able to do more for yourself by experimenting in an effort to learn the source of this interference than by listening to any suggestions which we might be able to make.

J. F., Jr., Danville, Ill.

If you are using an audion detector and a sensitive receiver, you should be able to get fair results with the antenna which you sketch. Your transmitting range, however, will be limited. It would be much better if you were able to stretch an antenna between the top of your galvanized iron pole and the roof of some nearby house or a tree.

* * *

C. N., Valdosta, Ga.

The instrument which you have in mind is called a telegraphone and consists of a steel wire traveling between two electric magnets. The messages are recorded upon this steel wire magnetically and upon running the wire through between the magnets a second time the message is reproduced. This instrument costs several hundred dollars.

* * *

B. J., Canton, China.

The design of the aerial of which you forward a sketch is as far as we are able to say O. K. If you have it available, you should, however, use copper instead of galvanized iron. Owing to the fact that you failed to tell us the length of this aerial, we are unable to give you the fundamental wavelength. You may figure this roughly for yourself by multiplying the overall length of wire (from the apparatus to the end of the antenna) in meters by 4.

* * *

C. P., Hartselle, Ala.

For the purchase of a small tape recorder, we refer you to J. H. Bunnell & Co., New York City.

* * *

W. H. O., Ridgewood, N. J.:

If you wish to increase the range of the set shown in figures 108 and 109 of "How to Conduct a Radio Club" to 18000 meters, a variable condenser having a capacity of .001 mf. should be substituted for C_2 and a like condenser shunted from the antenna to the earth. With reference to figure 109, increase C_1 and C_4 to .001 mf. and shunt a like condenser, antenna to earth.

* * *

R. J., Woodhaven, L. I.:

The April and May issues of The Wireless Age, contain diagrams and working drawings for construction of amateur receiving apparatus that will meet all your requirements.

The secondary voltage of a transformer for amateur work should lie between 15,000 and 18,000 volts.

Any electrical supply house in New York City can put you in touch with manufacturers that will construct special taps, binding posts, bushings, contacts, etc. for you.

Book Reviews

The Outlook for Research and Invention. By Nevil Monroe Hopkins, M. Sc., Ph. D. Cloth binding, 241 pages. Van Nostrand. Price $2 net.

With the expressed purpose of developing efficiency of research, Dr. Hopkins has prepared this book for the guidance of those who have the inventive turn of mind, but lack the facilities to determine the status of the prior art and the needs of the world in the broad field of technological development. The author has quite evidently designed his book for "tens of thousands of men working upon problems, in the history and conditions of which they are ignorant," noting moreover that "they are frequently working upon problems they are not educationally equipped to develop." The mere fact that inventions are patented at the rate

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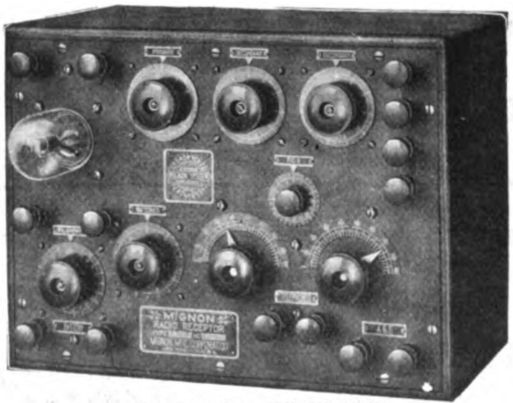

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of nearly 50,000 a year, but very few Americans are advancing the sciences at all, illustrates the need for a text such as the present one.

Eight chapters guide the reader to an understanding of the limitations of research, as well as its productive channels, equipment and methods, the canons being largely based upon the first-hand experience of the author. Every observation made is pertinent and clearly expressed; the guide posts set up are sharply defined and easily comprehended by the most inexperienced. It is refreshing to find a book with so serious a mission written from cover to cover with a simplicity of style that makes its reading less a task and more a pleasure. Contributing materially to its usefulness also is an appendix listing and describing problems awaiting solution in physics and chemistry, including a generous section on electricity and its application to radio.

This book is obtainable through the Book Dept., THE WIRELESS AGE.

Airplane Photography. By Herbert E. Ives. Cloth binding, 422 pages, 208 illustrations. Lippincott. Price $4 net.

The utility of the camera in association with flight has been obviously underrated, due to its military origin and cessation of the war-time demand. Future developments are certain, however, and it is one purpose of this volume to define the general principles which will apply to all uses and purposes which photographing from the air may be put. One of the lines of quickest development is described in a chapter devoted to pictorial and technical uses; it is in recording to best advantage the entire form and location of buildings, pictures which are destined to be extensively used in the study of architecture. The vertical aerial photograph, too, has such apparent advantages over any ordinary surveyor's map, that one logical use will be in advertising real estate developments. Landscape gardening, geological surveying, city planning, progress in engineering projects, the characteristics of wrecks, fires and floods for insurance underwriters, are among the uses the author selects as available for the peculiar merits of the view from the air.

A large portion of the book is devoted to a discussion of the fundamentals of photography, and to scientific methods of study, test and specification, so that the reader may understand the most advanced methods and perhaps contribute to future progress. A final chapter is devoted to future developments in apparatus and methods, prophesying the next steps in lens design, camera suspension, color photography and practical photographing at night.

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Inventions of the Great War. By A. Russell Bond. Cloth binding, 337 pages. Illustrated. Century. Price $1.75 net.

The more important and interesting inventions which were war-born or highly developed during the period of hostilities are described in simple language in this book. The story of research and development is fascinating in itself, but a great deal has been gained by the author's manner of including the human interest which lay behind solution of each problem. Of special interest to wireless men is the chapter, "Talking in the Sky," in which vacuum tube wonders are referred to, long distance radio is explained, airplane transmitting equipment is discussed in initial and later stages, high speed telegraphing methods are reviewed, and the utility of the radio compass described.

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The Realities of Modern Science. By John Mills. Cloth binding, 321 pages. Illustrated. Macmillan. Price $2.50 net.

For those who have been unable to comprehend the isolation of the electron, which has been discussed in numerous learned treatises by radio engineers, this volume offers an easy means to an understanding of the new terms by which scientists are explaining the phenomena of all physical science. To students of electricity who have not had the advantages of the more advanced courses Mr. Mills' book is invaluable, for most of the phenomena of electricity are treated in elementary texts without reference to the electron, now universally recognized as the fundamental entity.

As an introduction to the study of science the volume is particularly welcome. In chronological order it develops fundamental concepts, gradually leading up to important chapters on molecular and electronic motions.

This book is obtainable through the Book Dept., THE WIRELESS AGE.

Electricity at High Pressures and Frequencies. By Henry L. Transtrom. Cloth binding, 240 pages. Illustrated. J. G. Branch. Price $— net.

This volume bridges a gap for practical electricians who are interested in the subject of high pressures and frequencies but, due to the highly technical language employed by the average author, have been unable to get a real grasp of the subject. The high frequency currents of radio communication are clearly explained in principle and effect, not with the thoroughness demanded by the scientist, perhaps, but quite adequately for those who have not had the advantages of higher technological education.

This book is obtainable through the Book Dept., THE WIRELESS AGE.

Principles of Radio Transmission and Reception with Antenna and Coil Aerials. Bureau of Standards, Scientific Paper No. 354.

The functioning of the two principal types of radio aerials is worked out quantitatively from fundamental electro-magnetic theory. Experiments have verified the formulas and conclusions presented. Formulas for the current received in either antenna or coil aerial in terms of current in either type of transmitting aerial are given, as well as comparison formulas giving the relative performance of antenna and coil aerials under various conditions. The advantages of the condenser type of aerial are presented. The theory and nature of radiation are discussed, and applied to the elucidation of some current fallacies. The basic principles of design of aerials are given. Desirable lines of future research are pointed out. The use of the coil aerial as a direction finder, interference preventer, reducer of strays, and submarine aerial are *not* among the subjects treated.

The Determination of the Output Characteristics of Electron Tube Generators. Bureau of Standards.

Owing to saturation and rectification effects in three-electrode vacuum tubes, the currents which they deliver to any type of output circuit, when used as a generator, are heavily loaded with harmonics. Experimental results indicate that the frequency of the oscillating currents generated is the natural frequency of the output circuit. Hence this circuit behaves as a filter in series with the tube and the D. C. power system, and the useful output current is approximately sinusoidal, whatever the distortion of the tube currents, depending in amplitude solely upon the fundamental constituents of the tube currents. General expressions are derived for the power and current output in terms of static characteristics of the generating tube, and are corroborated by experimental results obtained with a particular tube.

These papers are now ready for distribution. Any one interested may obtain copies by addressing a request to Bureau of Standards, Washington, D. C.

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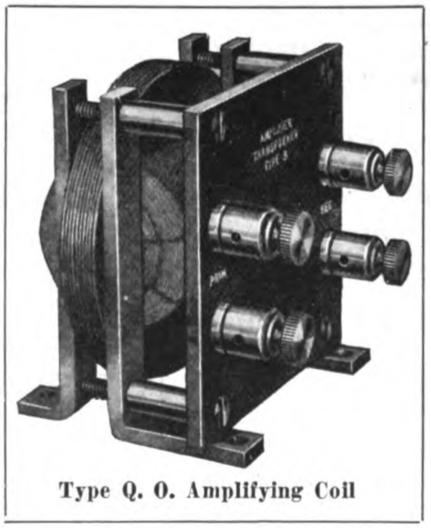

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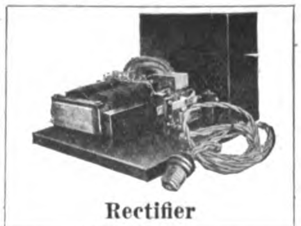

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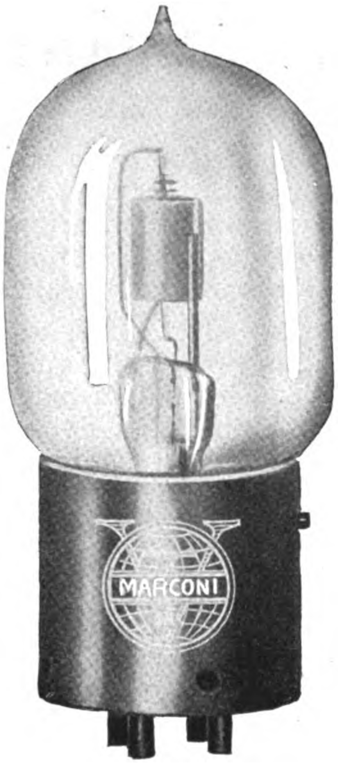

Fleming Pat. No. 803,684
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A WARNING

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Users of

Vacuum Tubes

The Marconi V.T. Patent is Basic

United States Letters Patent to Fleming, No. 803,684, November 7, 1905, has been held to be valid by Judge Mayer of the United States District Court for the Southern District of New York, and by the United States Circuit Court of Appeals for the Second Circuit.

It is a basic patent and controls broadly all vacuum tubes used as detectors, amplifiers or oscillions in radio work.

No one is authorized to make, sell, import or use such tubes for radio purposes, other than the owners of the patent and licensees thereunder. Any others making, selling, importing or using them alone or in combination with other devices, infringe upon the Fleming patent and are liable to a suit for injunction, damages and profits. And they will be prosecuted.

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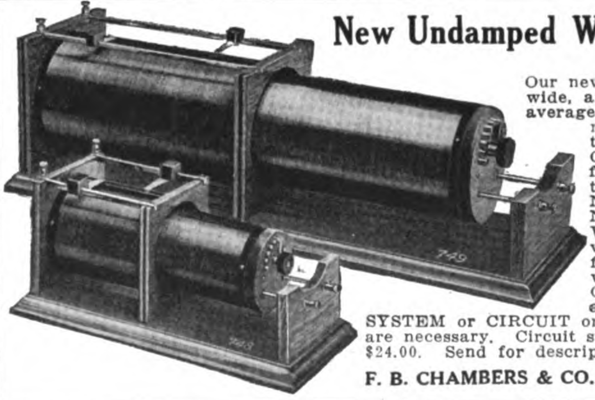

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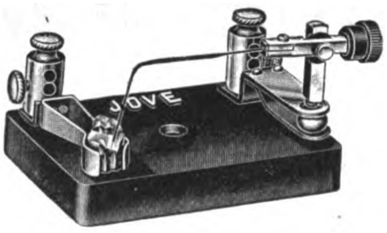

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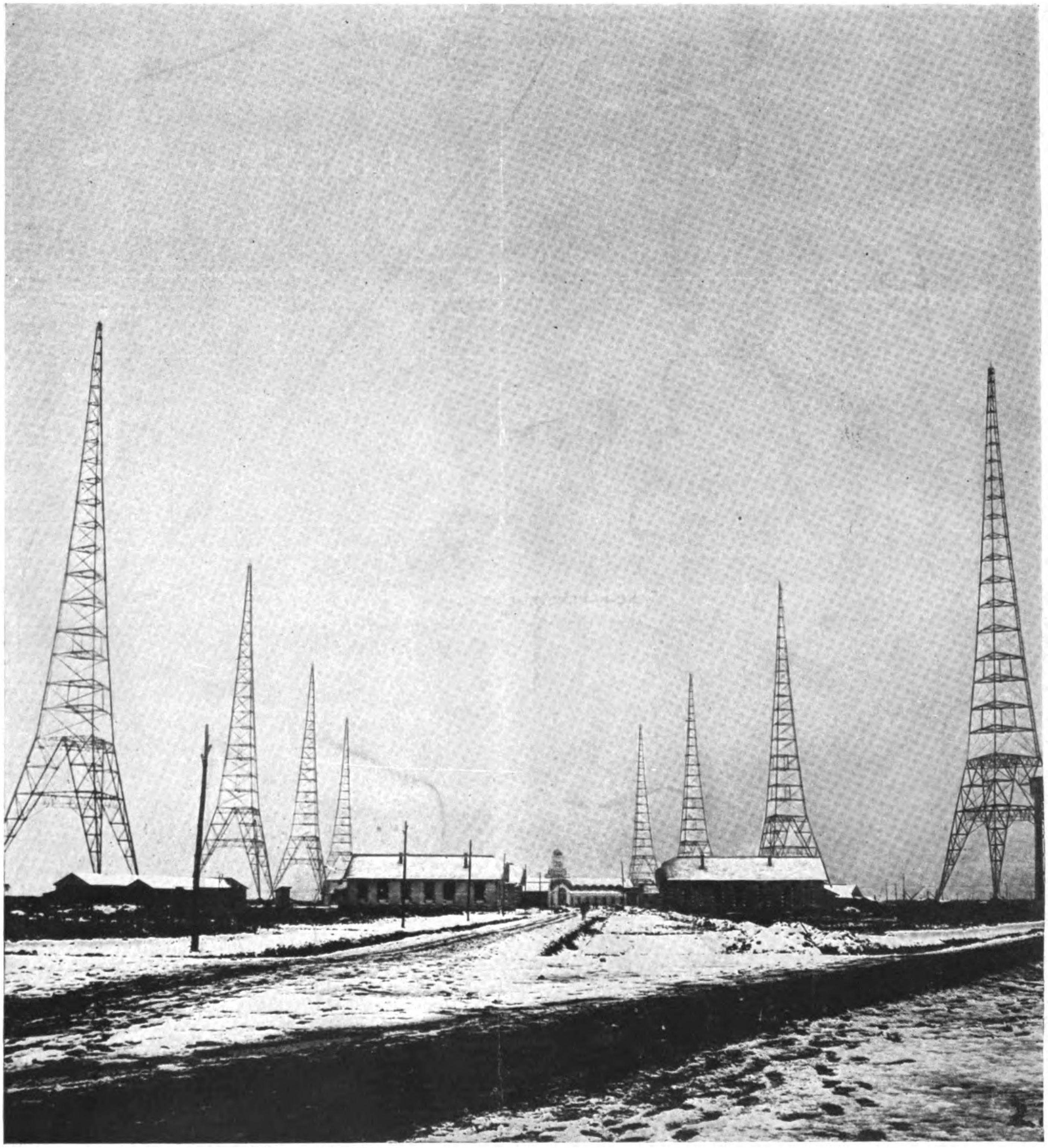
The WIRELESS AGE

Volume 7 Number 6



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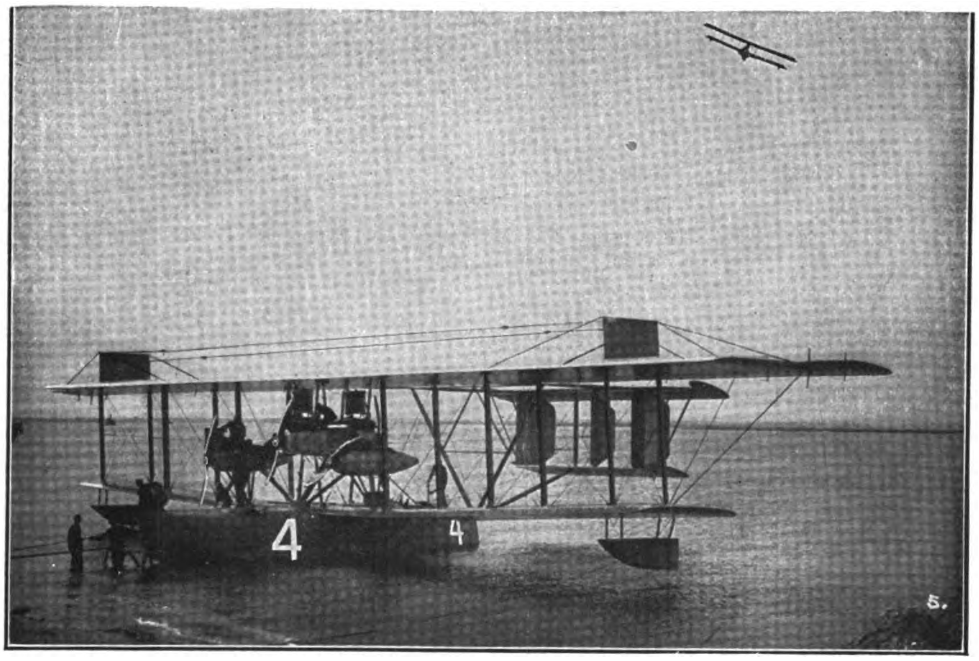
Extract from New York World, June 3, 1919.



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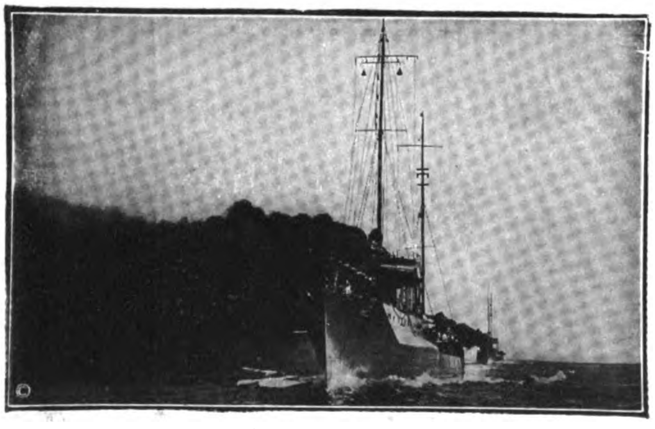
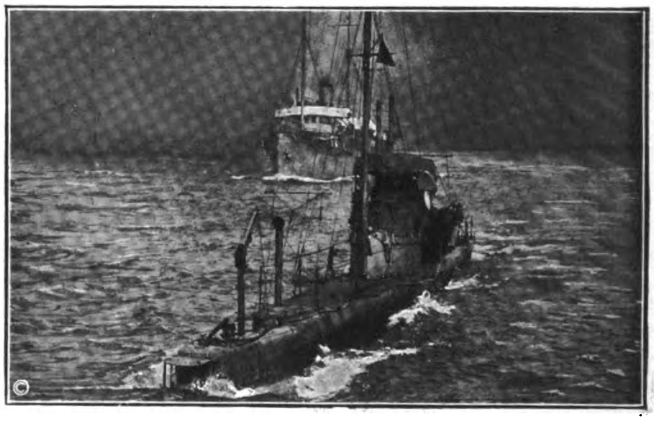


U. S. S. Cassin and U. S. S. McDougal Working Up a Smoke Screen—ELECTROSE Equipped.



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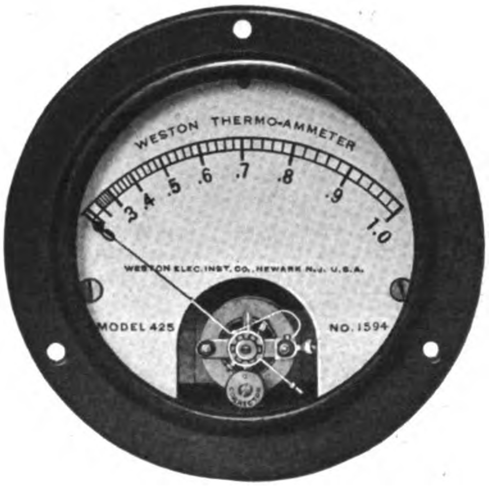

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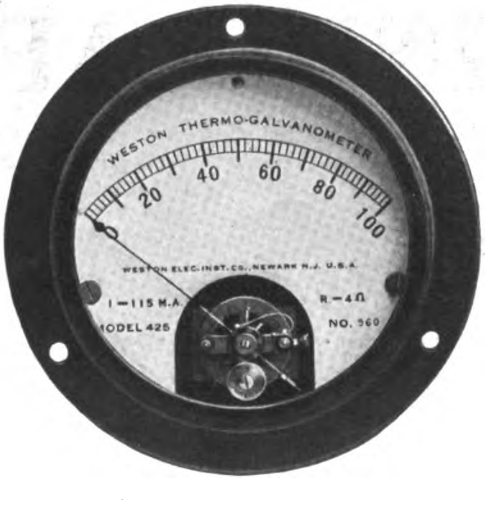
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Edited by J. ANDREW WHITE

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Owing to the fact that certain statements and expressions of opinion from correspondents and others appearing in these columns from time to time may be found to be the subject of controversy in scientific circles and in the courts, either now or in the future, and to sometimes involve questions of priority of invention and the comparative merits of apparatus employed in wireless signaling, the owners and publishers of this magazine positively and emphatically disclaim any privity or responsibility for any statements of opinion or partisan expressions if such should at any time appear herein.

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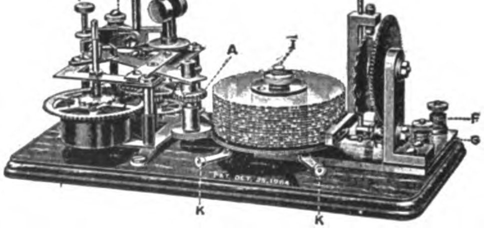

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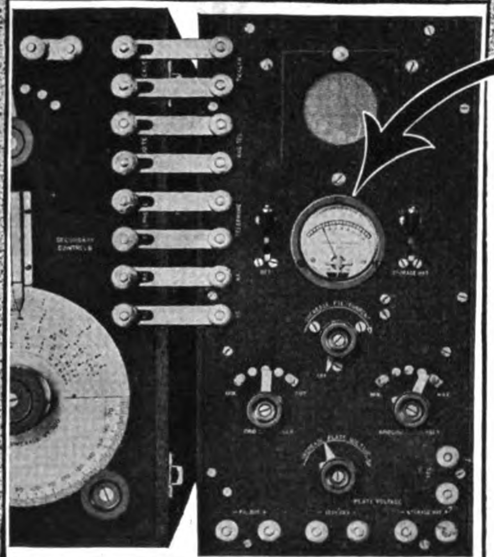

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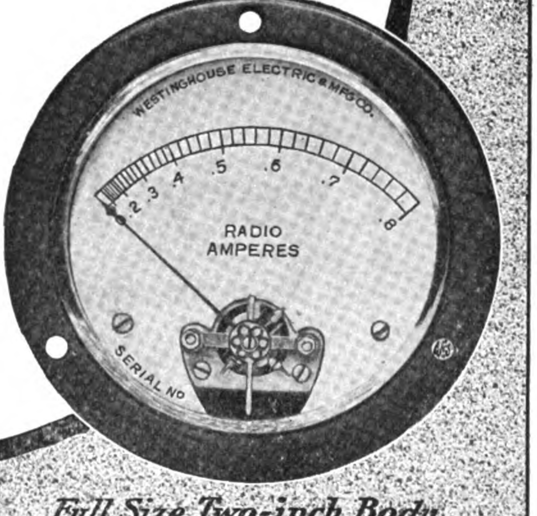

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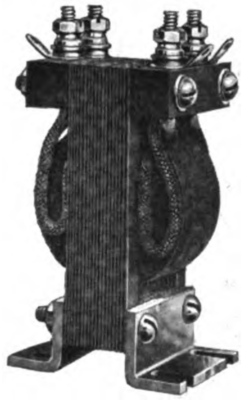

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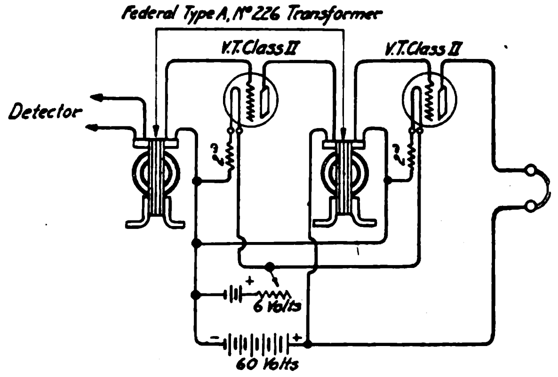

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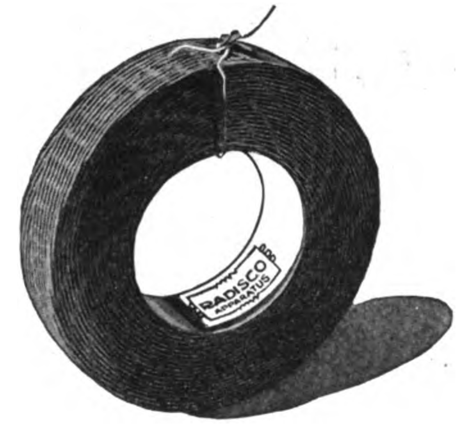

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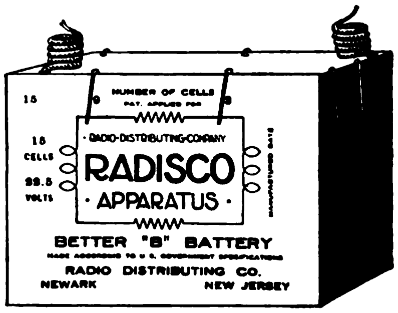

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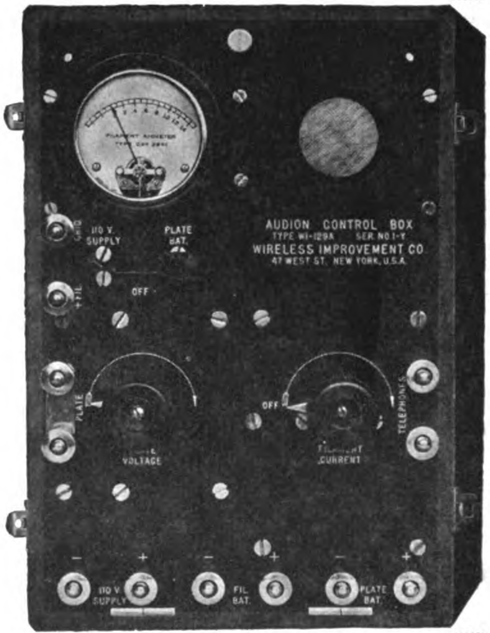
TWO STAGE AMPLIFIER
Type WI—125A

THE PHOTOGRAPH of the "WICONY" Type WI-125A Amplifier does not show up much better than ordinary amplifiers. An actual inspection of the instruments, however, immediately shows the difference.

We claim, without hesitation, that this instrument is electrically and mechanically the finest amplifier made in this country either for Navy, Army, or commercial account, It is an ultra refinement of the Navy Amplifier and, for those who require the best appearance as well as the best operating results, we offer it at a price which, comparatively speaking, is extremely low.

The above is equally true of our Audion Control Box, Type WI-129A, which contains a filter system so that it can be used on a 110 volt line as well as with a battery.

The price of either instrument is $75.00, which will be refunded without question if the purchaser is not fully satisfied.



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Type WI—129A

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47 West Street, New York, U. S. A.

If this page is cut out and appended to the same page cut from the editions to follow, a complete file of very interesting information will soon be available. (No. 3)

Vol. 7. No. 6. MARCH, 1920

THE WIRELESS AGE

WORLD WIDE WIRELESS

America and France Linked by Wireless Telephone

ANOTHER triumph of the wireless telephone is recorded. American engineers have succeeded in talking over the wireless telephone direct from New Brunswick, N. J., to points in France.

A. E. Reoch, plant engineer of the Radio Company of America, reports that the talk to France was accomplished at the New Brunswick wireless station of the company by using the new Alexanderson alternator.

Scientists who discussed the situation predicted that before next Summer wanes it will be possible to obtain a direct wireless connection with London, Paris, Berlin or even Tokio with the same ease as to call up any point on the wired long distance service and hear the human voice perfectly.

Marconi on the Future of Wireless

GUGLIELMO MARCONI, in a signed article in the Nuvo Giornale of Florence on the predicted revolution in wireless communication, says:

"Eventually science will find a way of directing electrical energy without wires in an absolutely straight line. The result will be less expenditure of energy for short distances and hence less expense for messages. Once directive control has been established we shall undoubtedly be able by means of powerful machines to girdle the whole world with waves of electric energy without wires."

Marconi describes a radio telegraphic receiver no bigger than a gramophone by means of which, without any other communication with the atmosphere, he receives all day in his study every scrap of wireless news sent to the European press. He says that very soon with an instrument of this kind "bankers, politicians and business men in general will be able from minute to minute to keep themselves in contact with both hemispheres." He continues:

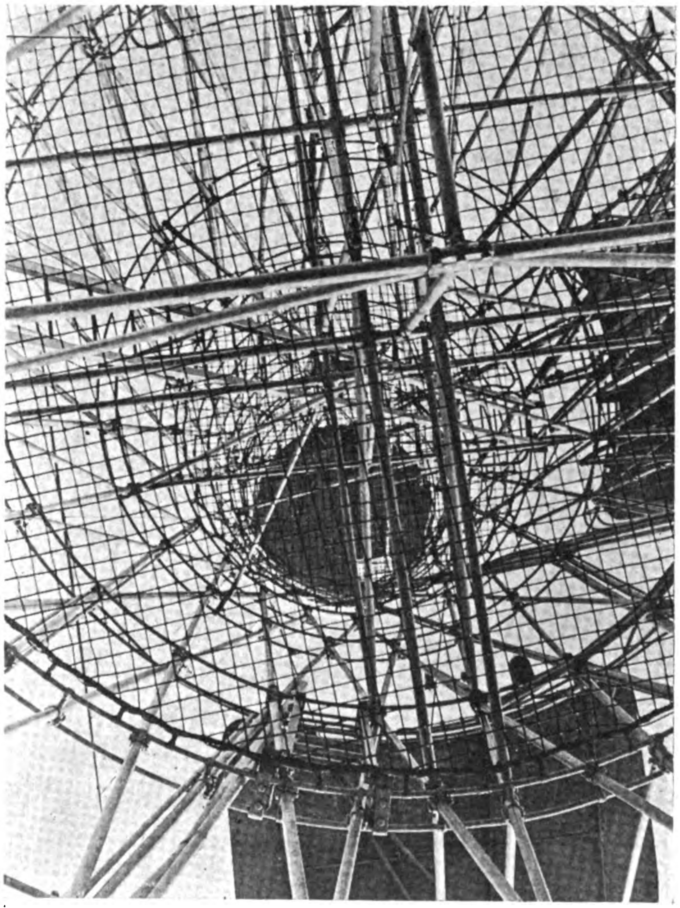
"Very soon, too, that miserable ticking machine on which all newspaper offices depend will yield place to this mighty invention, which is suitable for news sending, news receiving and simultaneous communication with any number of receiving stations.

"With that installment of radio telegraphic receivers throughout the civilized globe in every public school, university and library, the prevailing languid interest of the public in international happenings will be immensely stimulated."

An English Home Wireless Telephone

A COMPANY is offering for sale in Great Britain a "home wireless telephone" apparatus contained in a box light enough to be carried by a leather handle. It is said the outfit is capable of receiving messages from all the principal wireless stations in Europe.

It needs only to be placed on a table and the sounding telephones connected and it is ready for use. No external "aerial" is required. It costs $150.



This mystic maze becomes clear when it is explained that it is a view from the inside through the top of a wireless tower aboard the U. S. S. Army Rifle

Ban on German Wireless to American Press Lifted

AMERICAN correspondents in Berlin have had restored to them the privilege of using the direct wireless to America, as a result of vigorous protest by several newspaper men against the application to them of Paragraph 197 of the Versailles Treaty.

In answer to the protest which the American correspondents sent to the German Foreign Office and which was then placed before the naval sub-commission headed by Admiral Charlton, of the Inter-Allied Control Commission, the Foreign Office was advised that there is no objection to restoring the use of the wireless to the American press.

Congress Considers New Navy Radio Bill

CONSIDERATION of the Greene resolution sponsored by Secretary of the Navy Daniels authorizing the use of naval radio stations for commercial and press messages was begun March 1 by the House Committee on Merchant Marine and Fisheries.

The resolution states that in view of the recent executive order of the President returning all radio stations taken over by the Government to their owners and removing war-time restrictions, it is unlawful under the act of August 13, 1912, for the naval radio stations to handle commercial messages except where there is no commercial radio station operating continuously for general public service within 100 miles.

A strong effort has been made to induce Congress to authorize the Naval Communication Service to continue to handle commercial messages, not as a competitor of the private companies but as an aid to them, taking only such business as they cannot care for and at such rates as they have fixed.

Officers of the naval radio service have prepared a bill which gives the Government the right to transmit messages over its installations when communication through other channels is congested or for any reason interrupted. The measure also excludes private companies from the Canal Zone, certain of our Pacific possessions and unless authorized by the Government, from American possessions in the West Indies. All these areas will have a Government radio service and the naval coast stations will also be allowed to handle commercial messages between ships and the shore.

The plan also involves the transfer of radio control from the Commissioner of Navigation in the Department of Commerce, to a national radio commission of four members.

Savannah Gets New Navy Wireless Station

THE new wireless station in Savannah will be situated on the Ogeechee road site.

At present the station only has one 125-foot tower; the new station will have two.

The city contributes the site for the station. The new plant will be modern in every way with a California bungalow style of building.

Buffalo to Have New Government Radio Building

THE government is proposing the erection of a new radio building in Buffalo. According to a circular, sealed proposals for the building were sought.

The building, which is to be erected on army land adjacent to the lighthouse department grounds, will be two stories in height, of frame construction.

Movies Picture Operation of Wireless Telephone

THE wireless telephone is being presented as a scientific feature of the Goldwyn-Bray Pictograph. In the stress of the world war, the mechanism was perfected by which the human voice talks across the ocean, and the Bray Pictures Corporation shows how the marvel is accomplished. The device for transmitting electric waves which travel great distances is pictured so that even a child can understand how the electric waves are made to carry sound.

Wireless 'Phone Messages Between Berlin, Sweden and Moscow

TRIALS of the wireless telephone between Berlin and Karlsborg, Sweden, a distance of 435 miles, and between Berlin and Moscow, a distance of 1,055 miles, have proved successful, according to accounts of the tests in the Berlin press.

Wireless Reports Shipwreck Off Newfoundland

TWENTY-ONE men perished as a result of sinking off Newfoundland of the British steamer Bradboyne, formerly the War Panther, according to wireless advices received at the Marine and Fisheries Bureau.

A lifeboat from the steamship Oxonian, attempting to rescue the crew of the Bradboyne, was swamped, with loss of the second officer and five members of the crew. Fifteen men perished when the Bradboyne sank.

Captain G. D. Rees and second officer Bellas of the Bradboyne were picked up by the steamer Monmouth. The Oxonian wirelessed she was returning with 26 members of the Bradboyne's crew.

France Plans Colonial Wireless

THE head of the French government wireless department has worked out in detail a plan which, if it is adopted, will put France in wireless communication with all French territory the world over.

What he proposes is a continuous line of wireless stations of about 3,700 miles range which will include Tahiti, New Caledonia, Indo-China, Djibuti, Senegal, Martinique and France.

France, of course, would be the center of this world-wide system of communication, and would do its part with one station of medium power for the transmission of messages to North Africa and three stations of sufficient power to reach respectively the United States, Martinique and Brazil, and West Africa and Djibuti.

In addition to the four stations in France, the plan calls for three double stations, which means a large station and a medium one respectively, in West Africa, at Djibuti and in Indo-China; stations of high power at Martinique, Tahiti and New Caledonia, and stations of medium power in Morocco, Algeria, Tunisia, Congo, Madagascar and French India.

Peru Opens Two New Stations

THE Peruvian Department of Internal Affairs has announced that the radio stations which have been under construction for some time past at Eten and Trujillo are now in operation. This gives Peru a service without interruption from north to south, with stations at Paita, Eten, Trujillo, Lima, Callas, Pisco, Chala, Arequipa and Ilo. Radio stations were first established to provide communication between the capital and the eastern Mentana and Iquitos on the Amazon. This line, with relays at Pto. Bermudez, Masisea, Orellana and Requena, all points on the Ucayali river, has been in successful operation for the past decade and has proved of the greatest benefit, as a number of weeks are ordinarily consumed in making the overland trip from Lima to Iquitos, the head of river navigation in the Amazon basin.

Wireless Saves Man's Life at Sea

HOW a man's life was saved by wireless communication which changed the courses of two ships was told on the arrival at Baltimore of the Shipping Board steamer West Hartley, from Avonmouth and Manchester.

While the West Hartley was bound out from Baltimore on her last trip, Ignacio Minan, forty-eight years old, was taken seriously ill. There was no doctor on board, and Captain E. J. Preston, believing that a surgical operation was needed to save Minan's life, got into communication with the transport President Grant, eighty miles astern, bound for New York. The two ships turned about and met.

Minan was unconscious when the transfer was made in a small open boat. The operation was performed aboard the President Grant.

◆

Sister Missing 13 Years Found by Wireless

LOCATED by a wireless telegraph dispatch sent out from her brother's amateur plant, Cleo Archer, 17 years old, lost for 13 years, has been restored to her mother's home in Toledo.

Two weeks ago Lester Archer sent out a wireless call to all amateur plants within the radius of 800 miles, asking them to help locate his sister. Eventually he was informed that she could be found on a farm near Rockford, Ohio. Young Archer went to the farm of Ellis Williams and claimed his sister, who had been removed from a children's home near Lima, Ohio, thirteen years ago and had been sought by her mother in many cities.

◆

U. S. Weather Reports by Wireless

THE sending of weather forecasts by wireless telephone to Wisconsin farmers is a plan now being worked out by the United States weather bureau station at the University of Wisconsin, to carry information concerning sudden changes in weather more rapidly.

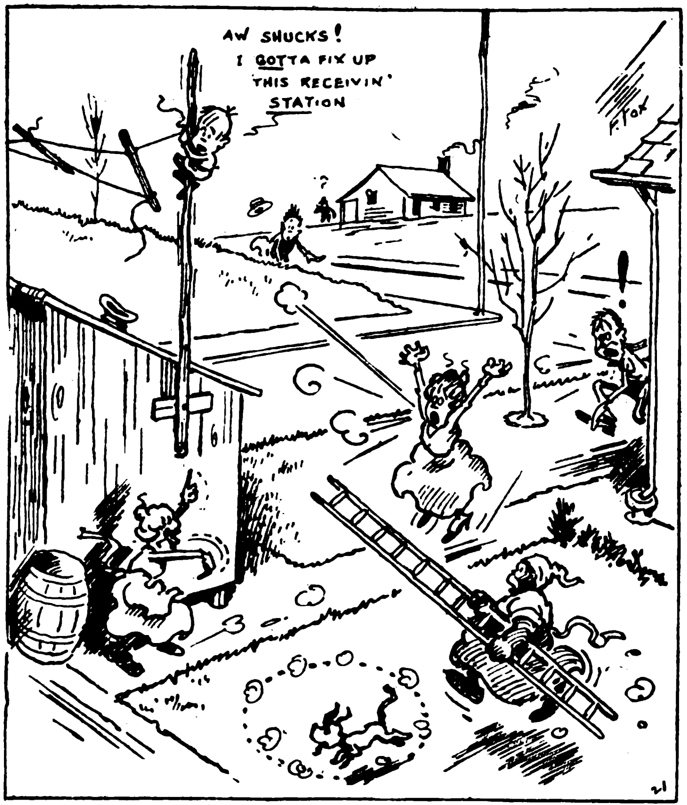
Such a plan will eliminate telegraph service and slow telephone communication to individual farmers. Farmers within a radius of 100 miles of Madison, who install an inexpensive wireless telephone receiving outfit, such as is now built commercially, will be able to receive the new service at a certain time every morning. No code need be learned for the wireless telephone message is received like a wire telephone message.

The present plan is for the weather bureau to send the weather report to the physics department at the university, to be sent out from the university wireless telephone station to all persons who wish to receive the service.

Shipping Losses Prevented by Wireless at New York Port

WHEN the most severe storm of late years struck the North Atlantic Coast recently, early warnings are credited with having prevented serious losses to shipping. The gale sweeping in from the sea reached a velocity of seventy-two miles at Block Island. Wireless requests for position were received in New York from thirty-nine ships which were uncertain of their bearing at sea.

Storm damage was general all along the coast from Boston to the Chesapeake. From practically every resort along the Jersey Coast came similar reports of damage to boardwalks, bath houses and beachfront buildings.


AW SHUCKS! I GOTTA FIX UP THIS RECEIVIN' STATION
F. Fox
21

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"The Wireless Disturbance"—Not mysterious enough, however, to be considered a possible message from Mars.—By Fontaine Fox

German Wireless News Service

THE first German paper to install a wireless plant for collection of news is the Danzig Gazette. The first dispatches have arrived without mutilation.

This is the first concrete result of the Giesberts plan to establish an entire chain of wireless stations connecting the larger papers of Germany.

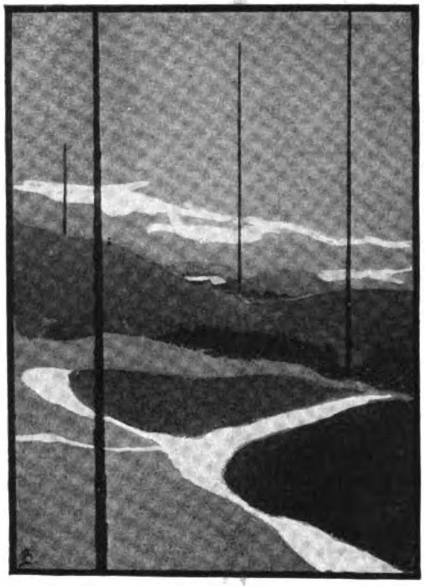
Two Timely Topics—

25-Mile Radiophone Transmitter Using Marconi V T's for 200-Meter Amateur Work.
The Coil Aerial—Its Use as a Direction Finder

—in the April Wireless Age

Commercial Radio Across Atlantic and Pacific Opens

First Direct Communication Between United States and Great Britain Inaugurated with Congratulatory Messages—Service to be Extended



COMMERCIAL wireless telegraphic communication direct from the United States across the Atlantic and Pacific oceans was realized for the first time at 12:01 o'clock on the morning of March 1st. The huge trans-oceanic wireless stations were turned over by the Government to the Radio Corporation of America at the stroke of midnight, February 29th.

The first wireless message since war control was lifted was sent through the New Brunswick (N. J.) station. The message marked an epoch in wireless history. Never before has there been established direct communication between the United States and England. Before the war the United States communicated with England by way of Canada. During the war the only wireless communication with England was under Government control.

Edward J. Nally, president of the Radio Corporation of America, issued the following statement:

"While the radio stations were controlled by the Navy Department, it was not possible for us to develop the full commercial possibilities of the wireless. The Radio Corporation of America, which took over the Marconi Company and all radio inventions and improvements of the General Electric Company, is now free to go ahead with the large plans for the development of a wireless service that will bring quick communication with all parts of the world.

"It will take some time to make the necessary readjustments. On the first day of the return of the wireless we devoted ourselves to communication between New York and Great Britain. In the near future we will develop the service with Norway.

"From San Francisco we are providing service with Honolulu and Japan. Later on, we will develop wireless communication with China, South America and the West Indies. Work is already being done in connection with a super-high power plant in South America."

Within a few weeks, the Radio Corporation expects to reopen the Tuckerton (N. J.) plant, which has been put out of commission by storms. This plant, which was partly under French ownership, was purchased some time ago and will be used for commercial communication with the high-power station at Lyons, France. Commercial communication with Norway will be by way of two stations in the neighborhood of Cape Cod. The duplex circuit will be employed. The Marion (Mass.) station will send to Stavanger, Norway, while Chatham, Mass., will receive messages sent from Naerboe, Norway. All four of these stations will have the same modern high-power equipment as the New York-Wales system.

The first three messages from the New Brunswick Station follow, in the order in which they were sent:

Godfrey C. Isaacs, Managing Director, Marconi's Wireless Telegraph Company, Ltd., London:

May this message, which opens commercial wireless telegraph service between America and England, mark an epoch in history from which the achievements of the future shall date. Communication is the leverage which shall lift the world to better understanding and thus lead to closer ties of friendship between all nations. It is the mission of our respective companies to so strengthen and improve the wireless service that distance shall be made negligible and communications practically instantaneous.

EDWARD J. NALLY.
President Radio Corporation of America.

President of the Chamber of Commerce, London:

Now that the war controls have ceased and the Radio Corporation of America has been honorably discharged from the service, we foresee closer and quicker business association, and we are confident that this new means of prompt communication and understanding will enable the business men of New York to work more closely with the business men of London, not merely to the advantage of themselves, but for the greater progress and benefit of civilization.

ALFRED E. MARLING, President.
New York Chamber of Commerce.

Imperial Commercial Association, 4 Callum Street, London, E. C. 3.

Upon the occasion of the opening of commercial wireless service between the United States and Great Britain, the Merchants Association of New York desires to extend to the Imperial Commercial Association of London its cordial greetings and its good wishes for the continued growth and success of your esteemed organization, and further to express the hope that the hearty co-operation with our association which has existed in the past may continue in the future.

WILLIAM FELLOWES MORGAN.
President, The Merchants Association of New York.

Mr. Nally received this reply to the first message:

Edward J. Nally, President, Radio Corporation of America, Woolworth Building, New York City:

Your first message by the new direct wireless service between America and England expresses exactly the desires animating the activities of every one here. We are certain that this day will pass into history as one upon which was forged a most valuable link of communication between the English-speaking peoples of two great continents. The British nation whole-heartedly desires the closest possible friendship with the United States of America, and my company, imbued with the national sentiment, will spare no pains in contributing to the fulfillment of this desire by assisting in the provision of practically instantaneous means of communication.

GODFREY C. ISAACS, Manager Director.
Marconi's Wireless Telegraph Co., Ltd.

Smaller stations reverting to private ownership include those of the United Fruit Company at New Orleans and Boston, the Mutual Telephone Company in the Hawaiian Islands, the International Radio Telegraph Company at Brooklyn, and Newport, and the Marquette and Bessemer Dock & Navigation Company, at Conneaut, O.

Interplanetary Radio Signals?

Varied Views On the Question Whether Inhabitants of Mars Have Been Trying to Signal Us By Radio

Guglielmo Marconi, who has protested against the interpretations put upon his original statement that mysterious radio signals may arise in any point of inter-planetary space

ARE there intelligent beings on the planet Mars, and have they been persistently signaling us by radio across several hundred million miles of interplanetary space? This is the question which has been agitating the scientific world for the past few months.

Interruption of the Marconi wireless instruments by mysterious undecipherable signals, which were noted before the war and have been publicly referred to since, were discussed by Marconi in an interview published by a London newspaper on January 27th.

"We occasionally get very queer sounds and indications, which might come from somewhere outside the earth," said Signor Marconi. "We have had them both in England and America. The Morse signal letters occur with much greater frequency than others, but we have never yet picked up anything that could be translated into a definite message.

"The fact that the signals have occurred simultaneously at New York and London with identical intensity seems to indicate that they must have originated at a very great distance. We have not yet the slightest proof of their origin. They might conceivably be due to some natural disturbance at a great distance—for instance, an eruption of the sun—causing electrical disturbances."

Asked whether possibly attempts were being made by another planet to communicate, Marconi said:—"I would not rule out the possibility of this, but there is no proof. We must investigate the matter much more thoroughly before we venture upon a definite explanation."

He added that the mysterious sounds are not confined to any particular diurnal period. They are equally frequent by day and night.

Marconi said that Morse signal letters occur with much greater frequency than others, but nothing has been picked up that could be translated into a definite message.

"They are sounds," Marconi added. "They may be signals; we do not know. They are not what operators call atmospherics, and we have nothing to guide us at present as to how they are caused. We do not get them unless we set up a special wave length, very much greater than the wave length ordinarily used. Sometimes there may be a long wait before we hear anything, or we may hear these sounds in twenty minutes or half an hour. They occur when we are using a wave length of approximately 100 kilometers (100,000 meters), which is three or four times the length used for commercial purposes."

"We have not yet the slightest proof of their origin."

Later, the distinguished inventor of wireless said that investigations are in progress regarding the origin of the mysterious signals, insisting that "nobody can yet say definitely whether they originate on the earth or in other worlds."

Probably no single statement relating to the radio art has caused more widespread comment. Opinions and discussions on the subject have come from all quarters of the globe. In the mass of material which has reached the Editor of WIRELESS AGE, many phases of the question are reviewed. It is impossible to deal with the multiplicity of angles and viewpoints represented, but a few selections have been made to the end of illustrating the diversity of thought on the subject.

Dr. E. F. W. Alexanderson, chief engineer of the Radio Corporation of America, states that no unusual interference or mysterious wireless signals have been noticed by the officials of his company. He believes that the disturbance, if any existed, was purely terrestrial since the persons who have noted it assert combinations of the Morse code have been received.

"It is impossible for the people of Mars or any other planet to know the Morse code," in his opinion. "The supposed signals which are considered unusual probably are produced by some spark station and are being heard at a greater distance than ordinarily because of the clearness of the atmosphere and the absence of static. The fact that the mysterious signals are partly decipherable bears out my contention."

Dr. Charles P. Steinmetz, inventor, and for many years the chief consulting engineer of the General Electric Company, believes it possible to communicate with Mars, but notes: "The probability that these strange wireless messages noted by Marconi really do come from Mars must, to the practical mind of the day, be regarded as a wild dream. It nevertheless opens up interesting scientific speculations, and we know that many of the speculations of half a century ago have now become tangible realities. If the United States, for instance, should go into the effort to send messages to Mars with the same degree of intensity and thoroughness with which we went into the war it is not at all improbable that the plan would succeed. To do so would mean the consolidation of all the electric power in the country into one great plant or sending station. Lofty towers would have to be erected, 1,000 feet high or more, and the cost of the attempt might be a billion dollars."

Dr. Steinmetz notes: "When Mars is nearest the earth the distance is about 50,000,000 miles, but the distance varies, and at certain periods Mars is as far as 250,000,000 miles away. These changes from extreme to extreme take place within a few years. It has been stated, I notice, that these strange messages apparently come in about 100 kilometer wave lengths, a little less than seventy miles. That is much longer than any wave lengths required for our greatest earth messages, and those lengths could be accurately measured. Now 100 kilometer wave lengths would be quite sufficient to transmit wireless signals through 50,000,000 miles of space or more. It is just about what we might expect in wireless communication with Mars.

"These messages must be received in the Morse code, for telegraph signals must come either short or long, that is, by dots or dashes. What makes them strange is that they are so mixed up that they cannot be understood. The proper thing to do when these strange messages come is to keep a careful record of them. If a number are received with the same degree of intensity in different parts of the world, say in London, New York and Australia, all being of these unusually great wave lengths, we could then reasonably suppose that they must have come from some point outside of the earth as the distances at the various places where they might be received would have no effect upon the result. In addition to noting the intensity of such messages at various places, by keeping a record of them it could be ascertained, when enough had been collected, whether any parts of these undecipherable Morse code messages were similar, that is, if there was a reasonable conformity in sequences of the strange code. If that could be proved, it would evidently indicate that they were sent from an intelligent source, but if no harmony could be found, it would be apparent they must be due to unexplained atmospheric conditions.

Dr. James Harris Rogers, sponsor of an underground wireless system hopes to receive signals from another planet

"Another evidence for determining whether these messages came from an intelligent source would be to note the force with which they come, as the distance between the earth and Mars changes within a few years. At 50,000,000 miles the signals would doubtless be stronger than when several million miles further away. Provided such records could be kept, we could surely arrive at a very definite conclusion as to their origin. It is true we might not be able to decipher the code, but it would indicate very satisfactorily that messages could be sent from one planet to another and that intelligent beings were inhabiting the planet from which they came."

The Mars theory may be all imagination and a wild dream, according to Dr. Steinmetz, but he values it as an interesting subject and one which is not without its possibilities of success.

E. Leon Chaffee, assistant professor of physics at Harvard University, thinks the so-called messages are nothing more or less than static. He believes: "There are two possible causes for the troublesome messages that have been bothering wireless operators by cutting in on their real messages. One of the most probable causes is extraordinary atmospheric disturbance, perhaps sun spots. The other, which is improbable, is that the interruptions are coming from some high-powered wireless station where experiments are being carried on in Japan or some distant country. That is only a bare possibility."

Interest manifestly outweighs skepticism among radio experts at the Navy Department. Proponents of the theory noted that they would enjoy the advantage of having no competent disputants, at least until science in some way accounted for the mysterious interruptions that had been experienced ever since wireless telegraphy was perfected.

"These interruptions or 'influences' are entirely distinct in their registering effect from influences readily traceable to atmospheric or static conditions," according to Captain W. S. Bryant of the naval communications service. "They record with a feeble or 'mushy' intensity as compared with the clashing effect of static disturbances. I confess that they have been a much greater source of annoyance, however, than of interest. Whether or not they emanate from Mars, as suggested by Marconi, seems to be an open question so far. It is at least one that affords pleasurable exercise for the imagination."

If the inhabitants of another planet do signal us it won't be in the Morse code, according to Prof. Harold Jacoby, head of the department of astronomy of Columbia University.

"Marconi speaks of the Morse signal letters occurring more often than any others," observes Prof. Jacoby, "and that fact alone seems to me to show that these messages are not extra-terrestrial, but come from some place on the earth.

"It is highly improbable that the people of another planet, if there are any such, would be acquainted with the Morse code, which is a complicated system of dashes and dots based on our alphabet. It was invented by Morse and cannot be regarded as universal among civilized peoples.

"Marconi cites the fact that the sounds have occurred with equal intensity in New York as in London as proof that they come from a very great distance. But it seems to me that this is only proof that they come from equal distances. The messages might be sent from some point equally distant from New York and London and yet not from a point beyond the earth."

If wireless messages are being received from some other planet the signals are not from Mars, but most probably from Venus, according to Dr. C. G. Abbot, Director of the Smithsonian Astrophysical Observatory and Assistant Secretary of the Smithsonian Institution. Dr. Abbot makes no claim that the mysterious wireless signals do come from another planet but says, if they do, Mars is eliminated as a possibility because known conditions on that planet probably would not permit the existence of any form of living creature.

Dr. Abbot notes the fact that on account of the greater distance, nearly two and one-half times less radiation from the sun reaches Mars than reaches the earth. It is probably nearly 100 per cent. colder on the average on that distant planet than on the earth. Knowing what low temperatures occur on this earth in the course of the winter season, it will readily be realized what 100 degrees colder would mean.

Intermittent waves, which seemed to be repeated with persistency, were recorded at the end of January at several wireless stations in Baltimore. The signals did not resemble a code but repeated a formula, over a wide range of wave lengths. It is said that they were heard with equal ease by commercial and amateur stations at a time when London announced that identical "messages" were being recorded in a British station.

Opinions expressed from Johns Hopkins University show scientists are divided on two theories—first, that the emanations are due to celestial disturbances, and, second, that the mystery may be explained by reactions from internal disturbances near the earth's core. Dr. Joseph S. Ames, professor of physics and director of the physical laboratory, thinks the information thus far made public by Marconi on the phenomena he observed is insufficient to provide a basis for scientific discussion.

That the undecipherable signals originate in some other world appears a possibility to J. Loring Arnold, professor of physics at New York University. He states:

"It seems to me not improbable that these unusual sounds may be caused either by some influence of the sun or by some planet's efforts to communicate with us. However, the latter explanation is mere supposition at best, and the great inventor's explanation seems the most logical."

Isabelle M. Lewis of the United States Naval Observatory believes that if Mars is indeed trying to signal to the inhabitants of our planet by wireless, a continual record of the nature and intensity of the disturbance will soon reveal the fact. The next six months should settle the question.

Dr. James Harris Rogers, sponsor of an underground wireless system, believes that within a year wireless communication will be established with Mars. He announces his intention to tune his receiving apparatus to 100,000 meters and hopes to get signals from another planet. He thinks that if Martians are sending their signals they selected this long wave length so as not to be confused by any signals used on this planet.

A New York radio engineer, L. J. Lesh, believes it possible to build a gigantic sending station and finally to devise a code for communication with the radio experts on Mars.

Although he believes that one of the methods of constructing a station would be to erect huge antennae suspended by balloons like the British dirigible R-34, he asserts that a still better way would be to use huge and brilliant shafts of light as antennae for the system. Still another idea put forward by him is that two immense sky-high towers be erected with wires or antennae suspended from them.

"Possible but not probable," is the comment on the Mars signaling made by Dr. Samuel A. Sheldon, head of the department of electrical engineering at Polytechnic Institute of Brooklyn.

"It is an interesting conjecture, but I should call it hardly scientific," he says. "Of course we would have to suppose that the Martians are an older and much wiser race than ours, and that they have learned a great deal more about sending wireless messages than anything we know. But even with that supposition a man must have a very vivid imagination to picture a sending station powerful enough to reach across the vast distances that lie between the two planets at their nearest approach.

"What may have caused the mysterious disturbances on Mr. Marconi's instruments has probably had a natural origin. We know there are certain black spots on the surface of the sun which recur periodically, and which are accompanied by electrical storms of unimaginable fury. We also know that these spots have been unusually large and variable during the last few months. What is more likely than that they have sent out radio waves which have jumped the gap between the sun and the earth and disturbed the instruments here and in London with an equal intensity?"

Commander R. L. McConnell of the U. S. Navy, radio supply officer at the Brooklyn Navy Yard, is equally skeptical of the Martian origin of any radio waves that have reached the earth.

He looks upon inter-planetary signaling, however, as an imaginable next step. According to his view, if the Martians have learned of the existence of radio waves, there are only two conceivable methods they would employ for signaling with them—the modulated (that is, the telephone) method and the interrupted or dot-and-dash method. Of these the dot-and-dash method would be the easiest and most probable to be used, as the telegraph was used before the telephone. Of course, their code would not be the same as ours, but it is not at all unlikely that some of their individual signals would correspond to letters of our Morse alphabet.

Charles P. Steinmetz, of the General Electric Co., notes that the Mars theory opens up interesting scientific speculation

"The power plant for such a radio station would have to be an enormous building, covering hundreds of acres. The antennae for such a station would reach half way across North America, and the cables used for it would be as thick as the largest tower of the group of buildings here in the Navy yard.

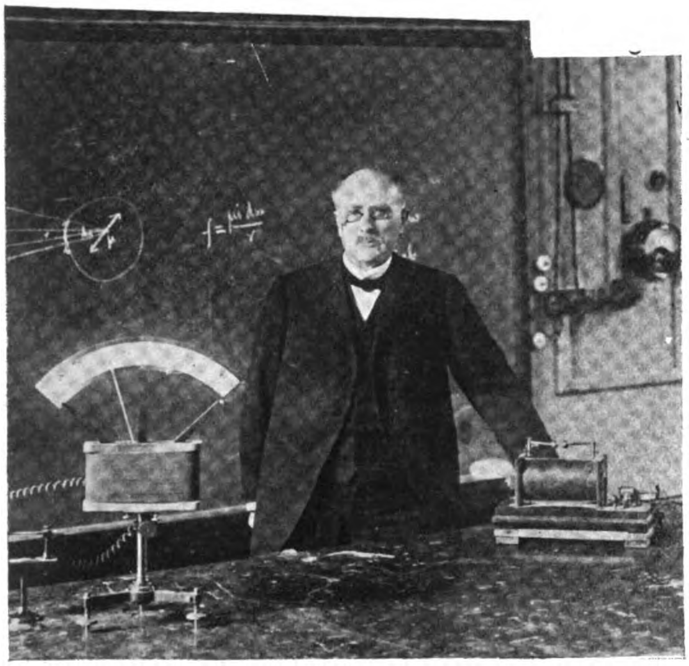
"That's what the Martians would have to construct on their planet to get their signals across to us. Perhaps they have done so. But it looks very improbable to me that they have."

Elmer A. Sperry, president of the Sperry Gyroscope Company, offers to send signals directly, by means of powerful searchlights, to the planet Mars; and then if there are any inhabitants there they can answer. Two hundred 60-inch searchlights such as were used in the war he thinks would do the trick, although he would wait until 1924, when the planets are nearest one another, before trying it

Dr. Louis Derr, of Massachusetts Institute of Technology, with much vigor denies that the messages occur from disturbances on the sun. "The sun is an enormous body that sends out magnetic storms like waves; they don't come in dots and dashes," he says. "You don't expect an elephant to dance a jig."

The wireless messages received at the Marconi station, in the Massachusetts professor's opinion, come from some distant worldly station.

Opinion from those of lesser attainments bulks large in quantity and quality. Many amateurs take the subject seriously; others deal with it in lighter vein. Even the lay public has had a large and generous say, for as one non-technical writer expresses it, "a great public stands respectfully attentive in the presence of specialized wisdom." After balancing skepticisms and desires, this man is forced to "the admission of a magnificent chance, and it is the magnificent chances that give zest to human life."



Prof. Edouard Branly, leader of French scientific opinion, who thinks the discussion of signals from Mars is based upon a highly improbable succession of coincidences

Another notes: "Certain it is that we are not always to be hermits in the great spaces of the skies. Certain it is that some time we shall find a language common to the universe and discover a means of communication. Perhaps the great Marconi is already on the way to the solving of the problem and the abolishment of the distances and the silences that now separate us from the other worlds and their peoples. The first message will be real news."

"The appeal of such a subject," observes another, "is hardly to be overestimated." In agreement with this view is one which characterizes the present "an ideal time in which to bring out this notion because the world is not prepared to believe almost anything except the obvious truth and we can already see an increase of interest in wireless which may stimulate the amateurs—if, indeed, they need stimulating in their fascinating work."

The disturbances may not be the result of efforts by other worlds to communicate with us, says one writer who evidently believes they are caused by the contestants in another great war on some distance planet.

Scores of opinions have been given on the value of the things we can learn from the Martians, who presumably have reached a more advanced civilization, yet through all of these runs the strain of doubt of communication success; a typical expression on this point is this one: "But when it is remembered that our wireless devices are the product not only of mind but of metals, and of long years of experimentation in a dozen branches of science, it's discouraging."

Then there are many who have written in facetious mood. Representative of the comment in lighter vein is the apprehension that the Martians won't care to communicate with us, that "we are not certain that whatever inhabitants the stars may hold would not be too uppish to lean over the cosmic fence and ask us how our gardens are getting on."

Some of the most amazing flights of fancy are to be found in American newspaper editorial comment. In one editorial column it is suggested that the signals "may come from the earth's center for all we know. Planetary transmission is doubted except in the automobile world." In another it is advanced that the undecipherable signals "may be nothing more than radio messages from Bolsheviki Russia explaining the beauties of the Lenine-Trotzky formula for perfect human happiness." In mock seriousness it is also commented: "They probably proceed from the inner consciousness of small nationalities, still clamoring for the right of self-determination."

The assertions of astronomers, eliminating Mars as the source of signals but conceding Venus as a possibility, have brought forth many fanciful constructions of the subject. One editorial complains that most of the earth's population are a bit "fed up" on the warlike planet at the present time "and would welcome more cordially overtures from almost any other planet." Another asks: "What could be a greater or more agreeable change than a transition from the harsh commands of Mars to the gentle influences of Venus?" It is also suggested that, "there appears to be only one way to settle the raging controversy, and that is by referring the decision to the ouija board." One writer pleads that there should be no doubt in the minds of thoughtful persons "that somebody, or some planet, somewhere, is trying to get in touch with the United States Senate," desiring "some pointers on the most marvelously incomprehensible doings that have ever been known." It is also urged that "scientists of this sphere perfect their receiving apparatus and discover a rosetta stone whereby the language of that other globe may be translated." This, presumably, will result in them "telling us what they think about prohibition."

Foreign comment also has some interesting features. Sir Frank W. Dyson, astronomer royal of Great Britain holds the opinion that it is quite possible to get waves from other planets. Sir Richard Gregory, professor of astronomy at Queens College, London, and editor of the scientific weekly *Nature,* thinks the whole proposition "unbelievable as well as a dream." Professor Howe is conservative but not scornful in his observation: "All we know is that electro-magnetic waves are received from an unknown source. The most important part of Signor Marconi's statement is his attribution of the noises to alphabetical letters. It is not inherently impossible that the people inhabiting Mars have a life, language and Morse code similar to ours." Mrs. Ellen Roberts Blackpool, however, is not content to stand by the stereotyped versions and in a London letter to Marconi advances the novel theory that "the spirits of departed wireless operators gone to other planets are trying to get into communication with you."

Italian opinion shows a wide division, Father Alfani, director of the Ximenian Observatory in Florence, terming the spread of rumors on planetary messages "absolutely scandalous," while Professor Domenico Argentieri, in this same city, thought: "Because of the regularity with which the signals have been observed, scientists believe they are due, not to mechanical, but to intelligent force." From Rome, word comes that the Vatican will make an investigation, the theory of planet signals being of such interest that Pope Benedict has directed Cardinal Maffi to make a report.

Absence of skepticism, too, is notable in the statement of Dr. Hubert Bianchi, M.P., who for many years was director of the Reggio Calabria wireless station. He says "that fifteen years of study and experimenting on the subject, convinced him that the mysterious signals are quite unexplained on the hypothesis either of earth currents or of disturbances arising from atmospheric discharges or even of stray signals from neighboring stations.

"When I began my investigations in 1905," he writes, "I noticed almost nightly, between midnight and 12.45, that our telephone and the Morse key inserted on a coherer wire, were registering rapid rhythmical signals, which could not be deciphered. These were followed by brief intervals of silence. The whole process resembled the regular transmission, only much quicker than normal. My corresponding station at the Villa San Giovanni and Messina never experienced phenomena of this sort."

Out of Germany comes word from Professor Einstein that he personally is "inclined to believe that these wireless interruptions are due either to atmospheric disturbances or secret experiments being carried on by some other system of wireless telegraphy." Professor Arrhenius, of the chair of physics in the Technical Institute at Stockholm, Sweden, thinks the planetary theory unworthy of serious consideration and believes it is more probable that the wireless apparatus may have been influenced by the sun.

The French Academy of Sciences evidently considers communication between the earth and the planets as among the possibilities. It has undertaken to act as judge for a prize of 100,000 francs ($20,000), to be given by the Academy for the best means of making a sign to a heavenly body and the receipt of a reply.

French savants are inclined to attribute the unexplained wireless impulses to earthly causes. Most of the French press treated the whole matter as a joke, under such headings as "Hello, Central give me the moon," but some of the more serious journals devote studied attention to the questions raised by Marconi.

Professor Edouard Branly, inventor of the coherer, thinks that the fact that signals come in letters of Morse code tends to discredit the theory that they are of other than earthly origin. He says:

"If we attribute these phenomenas to solar eruptions, how can we explain that they come in Morse? If we attribute them to inter-planetary sources (admitting that planets are inhabited), we must then admit that their people have reached a degree of development comparable to ours and that their science has led them to construct instruments similar to ours. This would be a succession of coincidences that I would call improbable.

"It might be that solar eruptions were the cause of wireless phenomena, since light has certain effects on electro-magnetic currents. It might be possible that these disturbances caused raps in our receiving instruments, but not letters of the Morse code."

General Ferrié, head of the military wireless, notes:

"We have heard nothing abnormal recently at the Eiffel Tower. We have disturbances which bother our communication, but they are continual. We attribute them to atmospheric variations and sometimes to the magnetic influence of the sun. We call them parasites of radio, but we do not think they are supernatural."

Marconi's original statement, in so seizing upon the imagination of the world, has been so widely discussed and distorted that a supplementary statement has been issued by the famous inventor. In this he says:

"I desire to protest against the interpretations that appear to have been put upon statements which I have made with regard to the possible sources of what are being termed mysterious messages from the unknown.

"Wireless messages are transmitted through the ether by the agency of electro-magnetic waves of definite lengths which can be adjusted, and in order to receive such messages the receivers must be tuned to the particular wave length that is used for transmission.

"At times signals are received which are apparently due to electro-magnetic waves of great length (up to hundreds of miles) and these signals are of the same character as those commonly called X's, or strays. Occasionally such signals can be imagined to correspond to the Morse signals for certain letters, and these signals occur at all seasons and irregularly.

"The sources of such signals are not known. They may be in the atmosphere or outside it and due to electrical disturbances. If outside the atmosphere they may arise in any point of inter-planetary space where it is well known electrical disturbances occur.

"Obviously, since the planet Mars is situated somewhere near inter-planetary space, the source of such signals might be on it or any other planet. There is nothing, however, to show that this is the case nor must any purely fanciful speculations of mine be interpreted to mean that I asserted having received any intelligible or unintelligible messages from Mars or from any other point in space outside the earth."

DASH DOT DOT DASH D
WIRELESS
I'M AS NERVOUS AS A CAT SINCE THE WAR
EARTH
BROWN

Hearing Things

Radio Operating as a Career

Just What to Do in Order to Become a Member of a Dignified, Fascinating and Highly Paid Occupation

By Pierre H. Boucheron

Formerly Naval Radio Instructor

The operator has many chances to study navigation

THE aftermath of war brings a new era of opportunities to the young man contemplating the study of radio telegraphy, either as a profession or as a stepping stone to radio engineering. There has been a great increase in the number of American vessels, and today it is indeed a small and unimportant ship which is not equipped with radio apparatus. At present there is a great demand for radio operators, a demand which greatly exceeds the supply, and which will probably continue for some time to come. It is no uncommon occurrence for a ship to be held up several days at a port, unable to sail on account of the scarcity of competent operators.

This state of affairs is hardly surprising when one considers that the number of American vessels is rapidly approaching the 3,000 mark, as compared with the few hundreds of pre-war days. Today, the Seven Seas are literally dotted with ships of the American merchant marine. Each ship means another opportunity. And this boom is not a temporary one, for it is inconceivable that the United States will relinquish its re-established position in ocean transportation.

This article will therefore concern itself with the advantages, opportunities and profit which may be had with remarkably little effort on the part of the average individual who aspires to become a radio operator, mentioning the most rapid and effective way in which he may prepare himself.

Primary Considerations

First, just what are the desirable qualifications? And are there any assets which materially assist in the business of preparation?

The most desirable age for beginners is within the years from 18 to 25, because during this period the mind readily absorbs new material, perception is more rapid and the senses are keener than at a later age. Particularly is this true in the matter of learning to read the Continental Morse telegraph code. It must not be inferred that an older man cannot learn the profession; it may take him longer to become proficient, but he has one advantage over the young one, for once he learns a subject his developed brain retains the knowledge more firmly than it remains in the more pliable mind of the younger man.

A common school education is sufficient. A high school or college graduate, however, may make more rapid progress, and he certainly will have decided advantages as he advances to more responsible positions.

Experience as a land line telegraph operator or familiarity with the Morse or Continental is an initial asset; ability to read signals on the sounder makes it possible to cut down two months of preliminary training in code practice.

The advanced radio amateur has a very material advantage over any other class of embryo Marconi, and with a little additional prepartion and study may easily secure a government commercial license.

Attending a School

There are several ways in which you may become a professional radio operator; your selection should naturally be the one most readily available to you under existing circumstances. For instance, if you are an absolute beginner, the most satisfactory start is to attend a reliable radio institute or school,* securing either day or evening instruction. With resident instruction you will learn the fundamentals of radio theory together with practical operation of all manner of apparatus, and will become proficient in sending and receiving messages. It is most important that you attain skill in key manipulation as quickly and as efficiently as possible, as it is really the stock-in-trade of the professional operator.

Mastery of the code is the most difficult task of the beginner. It is essential that you devote as much time as you possibly can to the practice of sending and receiving. Your progress in learning and the length of time it will take to complete your course depends materially on your sending and receiving speed. To complete a radio course at a resident school requires, roughly estimated, from two to four months and depends entirely on the following conditions:

1. Your previous knowledge of either radio or wire telegraphy.
2. The degree of enthusiasm, the adaptability and the consistency you display in your studies and *code practice.*
3. The extent of your education.
4. The amount of time you are able to devote to study. If it is necessary for you to earn your living while undergoing instruction, attending night classes is the most logical thing to do, although this, of course, may take a longer period of time than day instruction.
5. Your resources while learning, though this is really secondary, as tuition fees are very reasonable compared to other forms of instruction.

Home Study

Although attending a resident school is the most effective way for the novice to begin, it is nevertheless possible to become a proficient operator by home study; in fact a great many professionals have never attended radio schools nor received systematic technical instruction on the subject. The home student must, however, be very careful in code practice as it is very easy to acquire undesirable mannerisms and poor style of operating. Professional operators should be questioned on any points not quite clear, and from them should be learned the proper manner of holding the key, making and spacing telegraphic characters, how to copy signals accurately, and other points which must be specifically brought to the attention of the beginner in person.

It is very essential that the home student erect a complete radio receiving station, and if his means permit him, a sending outfit as well. The experience acquired in the process of installing will prove valuable in the future government examination, and a home station permits its owner to personally "listen-in" on *actual* radio operating and secure the necessary practice in receiving by intercepting and learning to copy press dispatches, weather reports, commercial messages, etc., in the regular operating fashion. The student, too, thus becomes familiar with the various forms of "static" or atmospheric disturbances and he learns to read signals during its presence, which is quite a feat in itself. The importance of learning to read through "static" is recognized by all schools, some of which have specially constructed automatic sending machines so arranged as to mingle artificial "static" among the transmitted signals, thereby teaching the student to copy through this form of interference. By having his own receiving set, the home student also becomes familiar with the art of "weeding-out" unwanted signals as well as reading and copying through a certain amount of interference.

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*Marconi Institute, New York City and San Francisco; various Y. M. C. A.'s; and the Eastern Radio Institute, Boston.

LEARNING TO RECEIVE

Sometimes it happens that after the home student has installed a receiving outfit, provided himself with a good text book on practical radio telegraphy,* and has had several weeks of practice, he finds himself unable to make out three consecutive letters while listening-in with his receiver. If this is the case he should not become discouraged, as this is due to his ear not having reached a point where it is readily able to quickly recognize and retain the meaning of each character while it is being transmitted. There are two general ways of acquiring the necessary receiving speed up to the point where the home student may at least read one or more words out of every five intercepted on his receiving set. One method is by securing the aid of a friend and devoting a certain amount of time to the practice of sending and receiving, each taking turns at sending and receiving. This method, to be of value, must be practiced in a systematic manner and in accordance with a carefully planned schedule. Little benefit is gained by practicing four hours one evening, and not at all during the remainder of the week. It is better to spend one hour each day in conscientious practice and keep it up consistently. Because resident schools are very insistent in the matter of regular code practice their students make good progress; it is required that from three to four hours be devoted to sending and receiving practice each day in the day classes, and from one to two hours in night sessions.

Another method of learning, which may be resorted to in the absence of a fellow-student, is by automatic sending machine.* These are usually operated by a clock spring or a small electric motor which causes a disc, cylinder or tape record to move in such a manner as to accurately reproduce the transmission of dots and dashes, either in connection with a high frequency buzzer and telephone head receivers, or with a telegraph sounder. The beginner may adjust the automatic transmitter so that it will send as slow as two or three words a minute and as the student gradually learns to quickly recognize each individual letter, the speed may be slowly increased up to twenty or twenty-five words per minute, which is the acknowledged practical and commercial speed of radio signaling today.

A word concerning sending and receiving. This concerns the school as well as the home student.

It is often asserted that sending is comparatively easy to learn while receiving is difficult. This is very misleading, for as a matter of fact, it is really quite a stunt to learn to send properly, while receiving is simply a matter of sufficient practice. At the present stage of the game it is really a delight as well as a rarity to hear a good sender, either radio or telegraph. This is largely due to improper sending instruction at the very start, resulting in the operator acquiring slip-shod and careless habits of making certain letters, such as sending *i* for *a*; *g* for *o*; *e* for *t*; etc., and unless the receiving operator at the other end has had considerable experience in reading all manner of sending he will be unable to properly copy the message. In consequence, time is lost by repetition, haranguing and the exchange of derogatory remarks, all of which is inefficient. The beginner should therefore be very particular in the manner in which he makes his characters. He should adopt a clear, decisive dot and dash form with the proper letter and word

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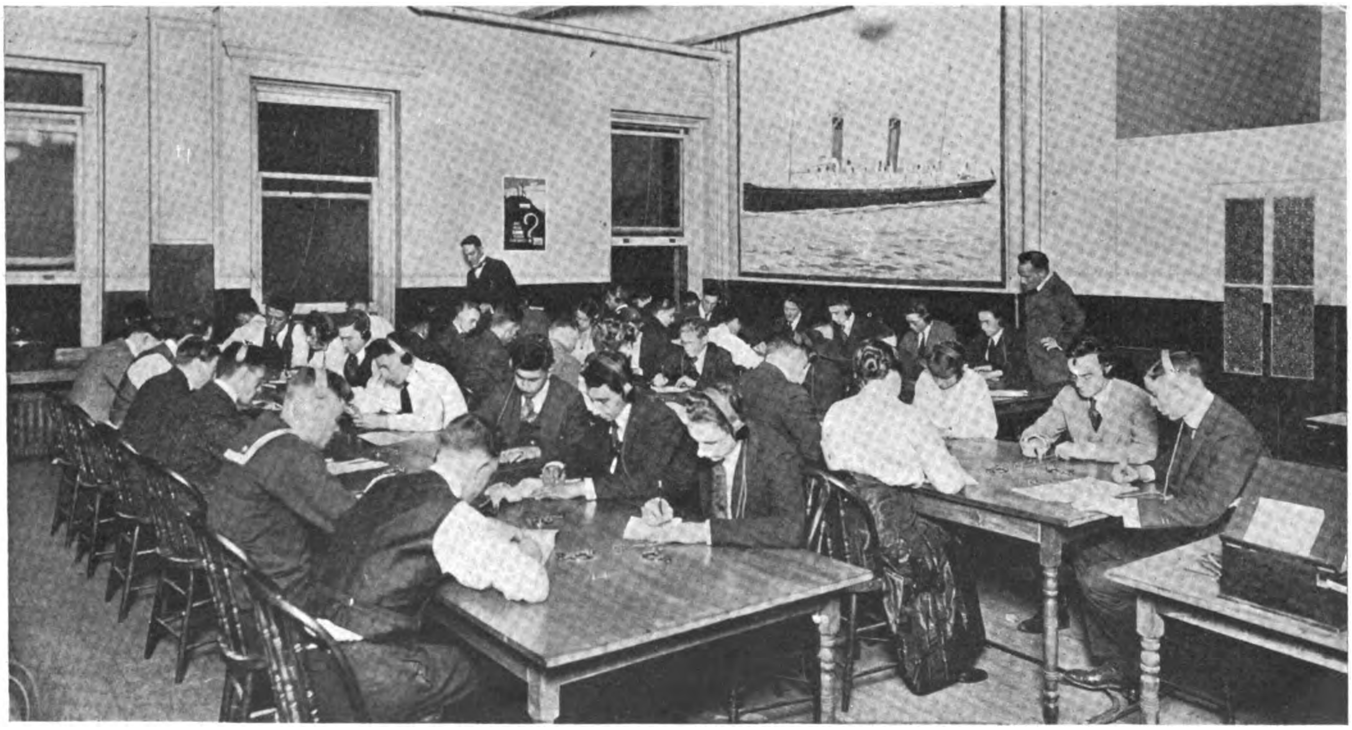
*Practical Wireless Telegraphy," Wireless Press, Inc., New York.

*The Omnigraph.

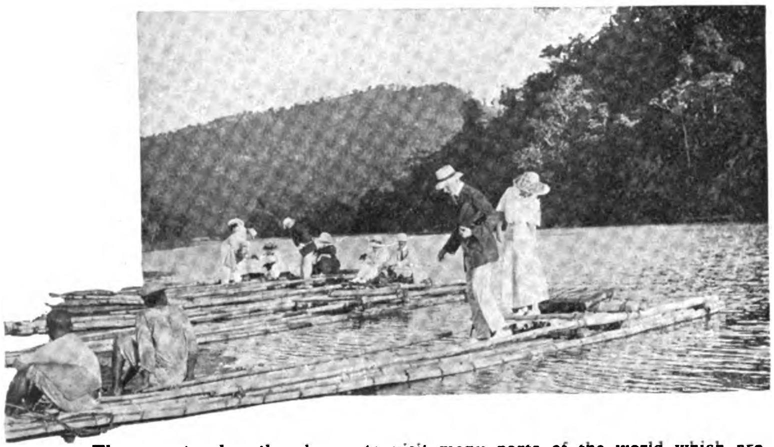


The most satisfactory start is made in attending a reliable radio institute or school, securing either day or evening instruction. The illustration shows a code class at the Marconi Institute

spacing and time interval. This factor is known and referred to by professional operators as *telegraphic judgment.*

There is also a right and wrong way to hold the key, and the wrong way is not conducive to the making of perfect dots and dashes. Use the first three fingers of your right hand, grasping the forward part of the key knob with the end of your thumb while the other two fingers reach out to the backward part of the knob, thereby insuring firm and yet pliable grip of the key. Also, the up and down motion should be controlled from the wrist and not from the finger ends, as is mostly done. The principle is the same as that employed in the Palmer handwriting method—it is a wrist motion and is meant to relieve the fingers from the strain of too-concentrated muscle action, thereby preventing "writers' cramp" or telegrapher's paralysis. Remember, it is just as easy to form right habits of sending at the beginning as it is to acquire wrong ones. If the right method is acquired at the start it will be retained to the end and clear-cut and easily readable sending will always be possible. On the other hand if the start is made with a careless and slipshod "fist" it will always remain a handicap.

Learning to read and copy radio signals fast and accurately is, after all, not as difficult as it may seem. The most trying and discouraging part for the beginner is from the time he first starts to the point where he can begin to copy a few consecutive words without error; when this point is reached the student takes on new life, so to speak, and he immediately begins to gain confidence in himself, which fact comes in good stead when later he attempts to copy actual signals straight out of the air.



The operator has the chance to visit many parts of the world which are seldom accessible to any but the very wealthy

In training naval radio operators during the war, it was found that the old method of sending plain English taken from a book or newspaper was improper and really retarded the student's receiving speed by giving him a false notion of his progress. This was due mainly to the unavoidable habit of guessing at words or writing down what he thought would be the following word, as well as due to the fact that the student secured practically no practice in receiving uncommon and seldom used letters, such as *x, z, q, j,* etc. In order to overcome this, meaningless and disconnected groups of letters comprising every letter of the alphabet, similar to code and cipher groups containing from four to ten letters each, were used exclusively, and this was kept up until the student had acquired a receiving speed of at least 15 words per minute, at which time he was permitted to, and could readily copy plain language or press items as well. The following are a few examples of code and cipher groups:

CODIAC	STQAINT	13084
NOMADE	NZOLXYO	78620
LASTOR	LZIMNST	59032

It is recommended that where two or more beginners have firmly resolved to learn to read the Continental Morse code, that they make up a series of practice sheets upon which has been written or typed all manner of letter and numeral combinations similar to the above, each sheet containing four, five or eight letters of code and cipher words. By the way, code usually refers to pronounceable words whether they have any dictionary meaning or not, such as LAMBASNOBE and YOKER, while cipher is an arrangement of unpronounceable letter or numeral groups having a prearranged meaning, such as LMXTO ZLNSA AOSLN 67542.

The Theory and Practical Side of Radio Operating

In addition to being proficient in sending and receiving the Morse Continental code, a professional radio operator must also be familiar with the theory and manner of operating every part of a ship or shore station installation. This can be learned from text books, coupled with a certain amount of actual experience with transmitting and receiving instruments, and this is where the advantage of attending a radio school becomes a factor.

A word of advice concerning this important subject.

Remember that in order to pass the government examination it is not sufficient that you simply learn by rote certain stock radio phrases and explanations and attempt to palm these off in the written examination. This will not do at all. You must actually know what you are writing about and know the subject well. The writer recently heard of several young men who felt very confident about passing the examination, referring to the questions as "the same old dope"; when taking the examination they answered all questions in monosylabic form, giving little or no detail and so abbreviated their answers that the examiners were unable to determine the extent of their knowledge of the subjects. As a result they were given so low a mark average that some failed to secure even a second grade license. It is most essential before you apply for permission to take the examination that you be fully versed in all subjects mentioned in another section of this article, and also that you be prepared to receive and transmit the Continental Morse code at a speed of not less than 20 words a minute—five letters to a word.

Grades of Licenses and Requirements

Before you can become a commercial radio operator, you must be examined as to your professional knowledge by government officials. If found qualified you will be granted a Commercial Radio Operator's License, of which there are three grades. The complete classification of licenses follows:

1. Commercial Extra First Grade.
2. Commercial First Grade.
3. Commercial Second Grade.
4. Commercial Cargo Grade.
5. Commercial Temporary Permit.
6. Experiment and Instruction Grade.
7. Amateur First Grade.
8. Amateur Second Grade.

In this article we shall confine ourselves to the most important commercial grades.

Commercial Extra First Grade: To be eligible for this license, an operator must have previously held a Commercial First Grade License, and have eighteen months or more of satisfactory sea or land service; it is only issued where trustworthiness and efficient service entitles the operator to confidence and recognition. The examination consists of the following subjects:

(a) Adjustment, operation and care of apparatus.

(b) Transmitting and sound reading at a speed of thirty words a minute Continental Morse, and thirty per minute American Morse.

(c) Use and care of storage batteries or other auxiliaries.

(d) Knowledge of International regulations and Act of Congress to regulate radio communication.

(e) Knowledge of U. S. Naval Radio Regulation.

COMMERCIAL FIRST GRADE: The applicant must pass a satisfactory examination in the following:

(a) The adjustment, operation, and care of the apparatus, including correction of faults and change from one wave to another.

(b) Transmitting and receiving by ear at a speed of not less than twenty words per minute in Continental Morse (five letters to the word).

(c) Use and care of storage batteries or other auxiliary power apparatus.

(d) Knowledge of the International Regulations in force applying to radio communication.

(e) Knowledge of the requirements of the Acts of Congress to Regulate Radio Communication (sections 3, 4, 5, 6, 7 of the Act of August 13, 1912).

The COMMERCIAL EXTRA FIRST GRADE and the COMMERCIAL FIRST GRADE LICENSES qualify holders for employment at any ship or land station of any class.

COMMERCIAL SECOND GRADE: The applicant must pass a satisfactory examination in all subjects prescribed for the first grade, with the exception that the minimum speed in transmitting and receiving shall be not less than twelve words a minute in Continental Morse, and the examination in the subjects will not be as comprehensive as that given first grade operators.

The student operator should provide himself with copies of the following publications which can be readily secured by addressing the Superintendent of Documents, Government Printing Office, Washington, D. C.:

Radio Communication Laws of the U. S.	15 cts.
Radio Stations of the United States	10 "
Radio Service Bulletin (issued monthly)	.05 "

(The above bulletin can be subscribed for at the rate of twenty-five cents a year).

Most of these publications are usually supplied by radio companies employing operators, but it is well for the aspiring professional to procure them himself and become familiar with their contents before attempting to take the examination.

WHERE AND HOW TO SECURE LICENSES

Commercial Radio operator's licenses as well as amateur licenses of all grades may be secured after due examination by applying to any of the following named places, where are situated representatives of the Department of Commerce:

Radio Service, Customs House, Boston, Mass.
Radio Service, Customs House, New York City, N. Y.
Radio Service, Customs House, Baltimore, Md.
Radio Service, Dept. of Commerce Bldg., Washington, D. C.
Radio Service, Citizens Bank Bldg., Norfolk, Va.
Radio Service, Customs House, New Orleans, La.
Radio Service, Customs House, San Francisco, Cal.
Radio Service, Customs House, Seattle, Wash.
Radio Service, Federal Building, Chicago, Ill.
Radio Service, Federal Building, Detroit, Mich.

REMUNERATION, ADVANTAGES AND OPPORTUNITIES

The present salary of the ship radio operator is $125.00 a month for senior operator and $100.00 for junior. In addition to this, operators are given first-class accommodations and meals, which is easily equivalent to an additional $50.00, when one considers the present high cost of living. While these figures represent the standard operating wage, operators may also earn additional money in other ways. For instance, on some cargo vessels where there is need of but one operator, the steamship company will arrange to have the operator act as supercargo in addition to his radio duties. For this combination position he receives a total monthly pay of $140.00 or more, depending on the importance of the voyage. This work requires very little preparation and is of a light clerical nature such as the making out of crew lists, manifests of cargo, store lists, etc. On other vessels, either passenger or cargo operators may check freight while at foreign ports. This consists of merely standing or sitting near the ship's hold and keeping count of the quantity and nature of the various items discharged or taken on board. This work pays from 40 to 50 cents an hour. On many passenger ships, too, the OCEAN WIRELESS NEWS is published as the daily newspaper of the sea. The operator in such cases is in effect an editor of the day's news transmitted from shore, and he is allowed a liberal commission on sales of the paper to passengers.

Misleading statements are often made concerning the recognized status of the radio man on board ship, so a few words about this matter is perhaps not out of place. The United States Shipping Board Emergency Fleet Corporation states in its contract with the radio companies the following:

"Radio operators shall be treated as officers, but without executive authority, and shall be provided accommodations suitable for an officer."

It is very essential that the home student erect a receiving station

This means that the radio man is accorded all rights and privileges of a merchant vessel officer, except that he has not the authority to give executive orders to any member of the crew unless he has been specifically instructed to do so by the captain or other accredited officer of the ship. This, of course, is quite natural, since the operator is in a class by himself and is not versed in any of the ship's routine.

The opportunities of the sea-going operator are manifold. In the first place, he has the chance to visit many parts of the world which are seldom accessible to any but the very wealthy. The radio operator having spare time at his disposal while at sea can study various subjects connected with his profession, such as radio traffic problems and the higher branches of radio engineering. By doing this, he may, after a few years of faithful service and study, be advanced to such positions as inspector, constructor, chief operator, assistant superintendent, representative, manager of coastal station, and various other well paying posts connected with high power transoceanic shore stations. Or, if he so desires, and wishes to follow the sea as a profession, he may study navigation.

There is certainly a great deal to be said in favor of radio operating as a profession, and few land vocations can boast of as fascinating and profitable a career as that of radio.

Testing Marconi V T's

The Electrical and Mechanical Tests That Are Necessary to Insure Efficient Tubes

WITHOUT doubt, there are but few of the readers of this magazine who have considered the care and effort that is required to produce uniformly good vacuum tubes. A summary of the tests through which the Marconi VT's pass will be of interest to those who use vacuum tubes in their experimental work.

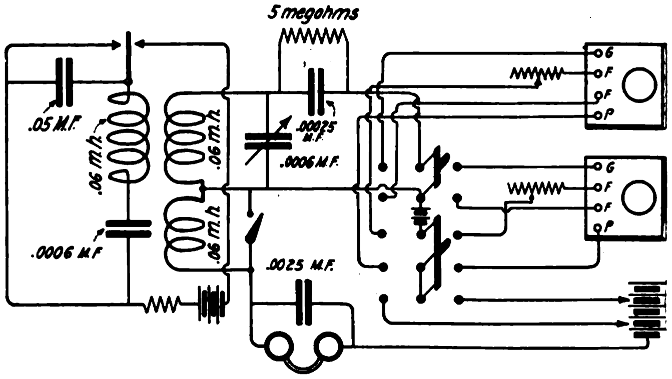


Figure 1—The circuit for the oscillation test at 250 meters

In addition to the electrical inspection, these tubes are also carefully inspected for mechanical defects to insure that the internal elements as well as the glass and base itself are all properly constructed and in line.

The electrical inspection—which is made to determine the operating characteristic of the tube—calls, first, for a filament which will pass a certain standard current under given conditions; second, the plate voltage required for the tubes must not fall below or exceed given values; next, the insulation resistance is measured between the plate and grid and filament terminals, this latter measurement being made only after the tube has been operating for a considerable period of time at normal current.

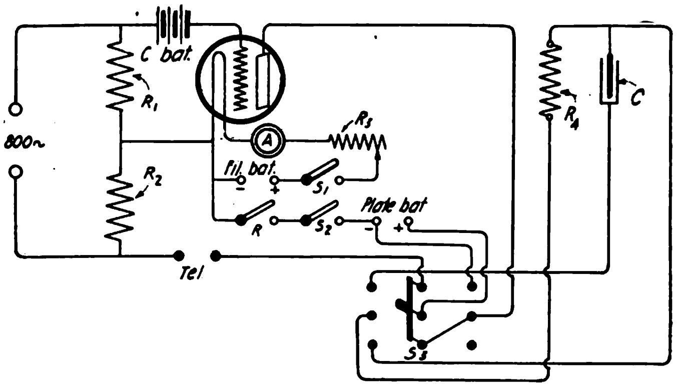


Figure 4—Circuit diagram of the Miller's bridge

The sensitivity of the tube as a detector is also carefully noted and checked against a standard in the test laboratory, and finally the tubes are connected in a circuit as shown in figure 1, for the oscillation test, where they must oscillate at a wave length of 250 meters, in a satisfactory manner, at a plate potential not greater than that required for the greatest sensitivity as a detector.

The Class II tubes are all subjected to a plate potential of 350 volts, which they must withstand for a certain

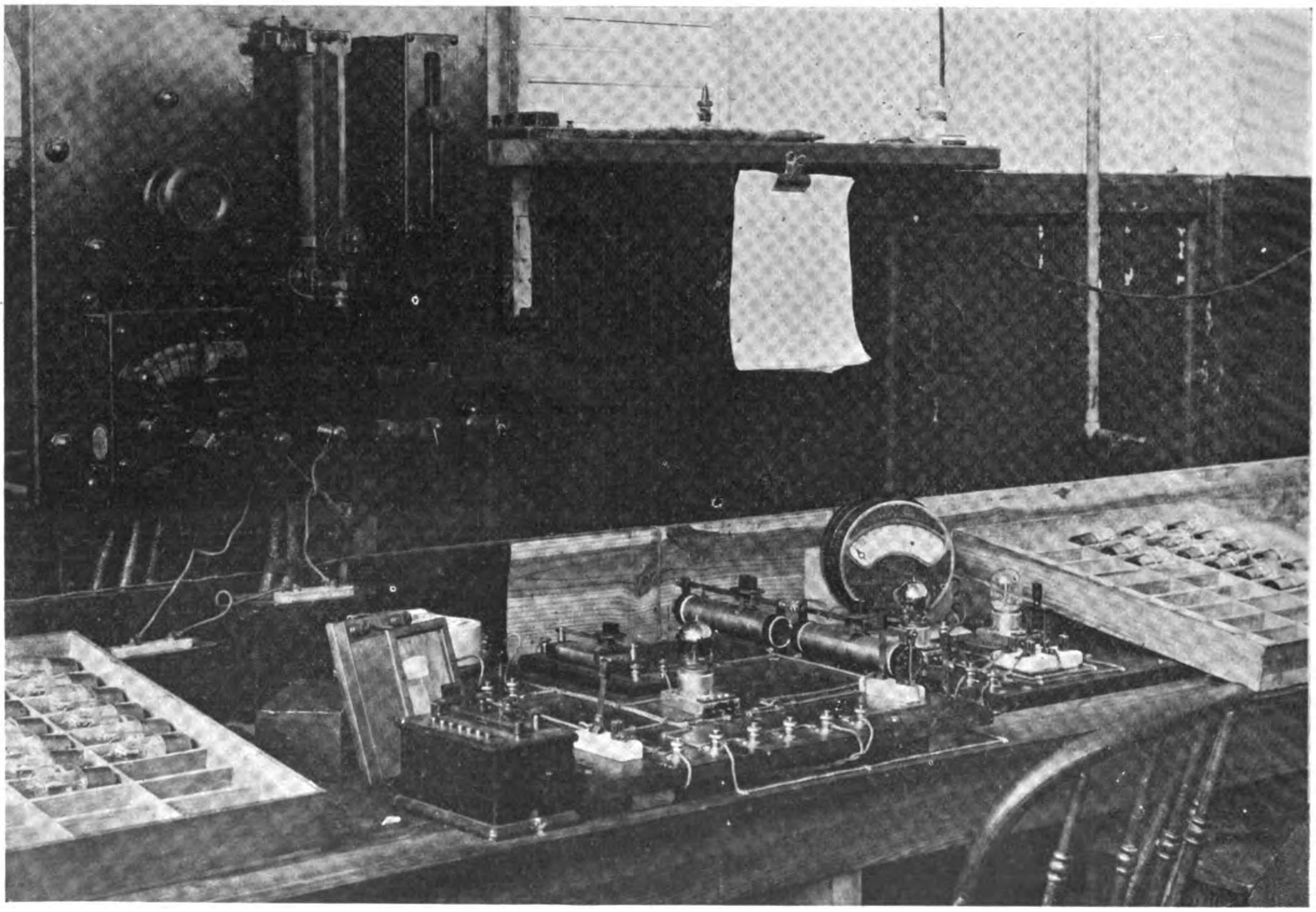


Figure 2—The layout used in the test for Class II tubes, subjected to a plate potential of 350 volts

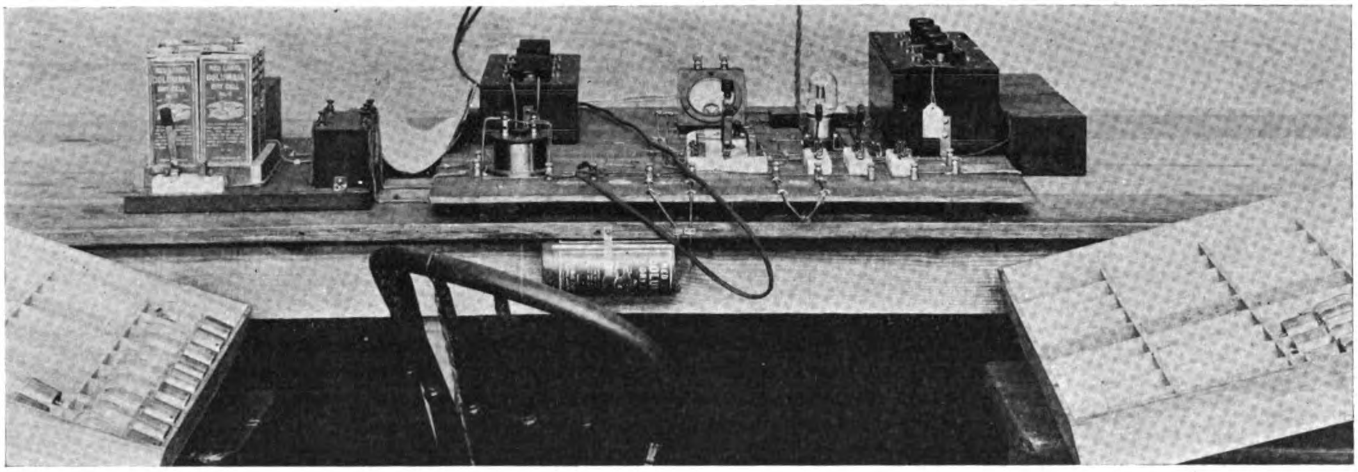


Figure 3—The instruments which make it possible to obtain the amplification constants, the internal resistance, and the voltage amplification of a tube when used with a resistance in its plate circuit

period of time or be rejected. Figure 2 is a photograph of the layout for this test. To the right is seen the plate circuit voltmeter (shunted) as well as the rheostats for the regulation of plate potential. Filament current rheostat is shown directly behind the left hand vacuum tube and the galvanometer for indicating grid current is shown beneath the generator board and directly behind a shunt resistance, the latter being connected across the terminals of the galvanometer in order to protect it in case of shorted connections within the tube under test. Figure 3 shows a photograph of a Miller's bridge set up by the use of which it is possible to obtain the amplification constants, the internal resistance, and the voltage amplification of a tube when used with a resistance in its plate circuit. A circuit diagram of the Miller's bridge is shown in figure 4. The action and operation of this bridge is described in Volume 6 of the Proceedings of the Institute of Radio Engineers. In figure 5 is shown a set-up for the oscillation test and for the detector test. A standard Navy short wave receiver as well as a standard Navy vacuum tube control box as manufactured by the Marconi Company and General Electric Company, respectively, are used in this test. A damped oscillation is supplied by the small oscillation generator on the left.

To summarize, all tubes are first tested for gas and classified as either soft tubes (Class I—detectors and oscillators) or as hard tubes (Class II—amplifiers, oscillators and detectors). The soft tubes are then tested for sensitivity as detectors, and either passed or rejected. The hard tubes are tested for amplification constant, and for oscillations, and either accepted or thrown out.

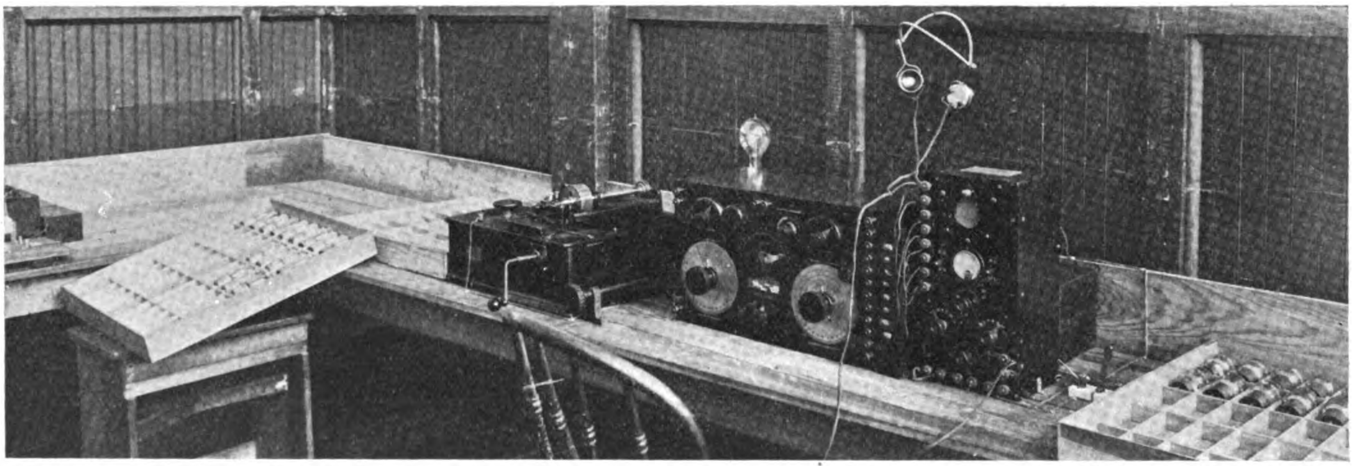


Figure 5—Apparatus for making the oscillation test and the detector test

If You Were the Editor—

It is an axiom in any magazine publisher's office that every reader is certain that the publication would be improved if the ideas he holds were adopted.

We like this spirit. We want to hear those who think The Wireless Age is not quite as good as it should be.

Let us have all those fine suggestions. It will be worth your while, for we are going to give you whatever it is you think you want.

The majority will rule, but all reasonable requests for departments or articles will be given most careful attention. —The Editor

Condenser Construction

To those who have in mind the construction of condensers the method used by Dubilier will be of interest. The principal object of his method is to provide a condenser in which the terminal connections will fall at points spaced to such an extent that the liability of an electrical discharge between terminals at different potentials is minimized, and to avoid the necessity of employing special insulating barriers or plates between the terminal connections.

Figures 1, 2 and 3 are respectively top, side, and perspective views of a condenser, made in accordance with this method. Figures 4, 5 and 6 are views which correspond respectively to figures 1, 2 and 3, but which show another method of making connections.

With reference to figures 1 to 3, a condenser is shown consisting of several conducting plates separated by mica sheets, the plates and sheets being assembled into a rectangular shaped block. Groups of conducting plates are connected in parallel so as to form several sets of plates insulated from each other, these being of opposite polarity and connected in series to divide up the potential to which the condenser is to be subjected to such an extent as to prevent a failure of insulation or a breakdown in any portion of the insulation.

Terminals for each set of plates are provided by extending the edge portions of the plates a short distance beyond the face of the block. The terminals of the different sets are then connected so as to place the requisite number of plates in series with each other.

In order to prevent a discharge between terminals which are to be at different potentials, these terminals and their connections are brought out at different points around the sides of the block so that each terminal will be spaced a relatively large distance from the others. In figures 1 to 3 this is accomplished by bringing out the terminals of successive sets on different faces of the block, the terminals of the sets of opposite polarity in the top layer being brought out for instance at sides 4 and 6 respectively of the block and the terminals of the sets of opposite polarity in the second layer being brought out respectively at sides 3 and 5 of the block, the terminals for the sets of the third layer at sides 4 and 6, and so on. The top terminal on side 6 of the block, may then be connected by a conducting strip to the second terminal on the face 5 of the block. The terminal of the second layer, which is on face 3 of the block may then be connected by a similar ribbon to the terminal of the third layer which is in face 6 of the block. The terminal of the third layer, which is on face 4 of the block, may then be connected to the terminal of the fourth layer which is on face 3 of the block. The terminal of the fourth layer which is face 5 of the block may be connected to the terminal of the fifth layer which is on face 4 of the block, and so on.

It will thus be seen that with the above arrangement the terminal connections extend around the sides of the block in a spiral fashion. In the form shown in figures 1 to 3, the terminals 8 to 12 for instance are spaced a distance equal to the thickness of 3 groups of plates so that the chances of a discharge between such connections are minimized.

If the terminal connection between successive groups of plates be made alternately at opposite sides of the block as has been the usual practice, it is necessary to

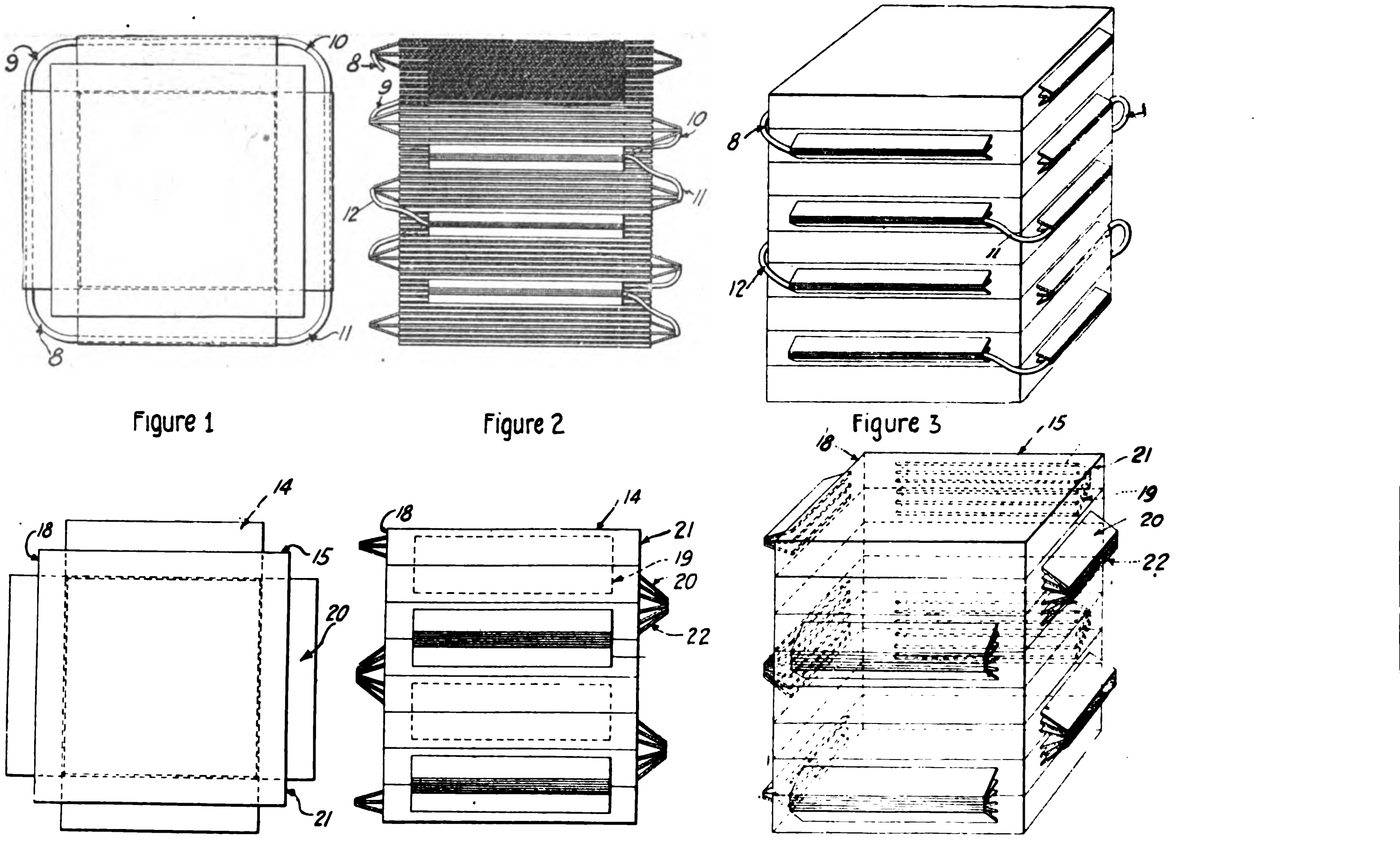


Figure 1 Figure 2 Figure 3

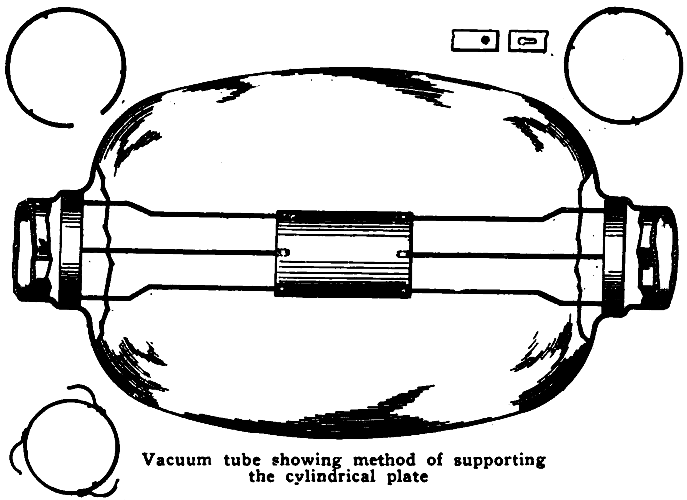
Figure 4 Figure 5 Figure 6

Figures 1, 2 and 3 are respectively top, side and perspective views of the condenser and figures 4, 5 and 6 show another method of making connections interpose between terminals and connections of different potentials insulating barriers or plates, so as to prevent brush discharge, but these insulating plates aside from the greater expense they entail, are awkward because they leave the condenser terminals in pockets or recesses with the result that such terminals are not readily accessible for making terminal connections. With a condenser constructed as per above outline the greater spacing between the connections obviates the necessity of employing insulating barriers between them, and no more insulation need be interposed between the superposed groups of plates than is used between the different plates of the interleaved groups.

Figures 4 to 6 show a condenser of different construction, but in which the same principle of connection is employed. As shown in figure 4, a group of condenser plates may be connected in parallel and provided with a terminal on one face of the block similar to the one previously described. A second group of plates is interleaved with the first but has its common terminal located for instance at the side 18 of the block adjacent to the side 15 which carries the first terminal. The interleaved groups of plates in the second layer may then have one terminal located at the side 15 of the block and the second terminal located at the side 21 of the block, etc. Terminals 14 and 19, 20 and 22, etc. may then be joined together to connect as many of the groups in series as is desired.

Vacuum Tube Construction

A NOVEL means of supporting the electrodes in a vacuum tube has been worked out by T. P. Driver, of London. A cylindrical plate which is supported from both ends is provided at each end with a set of longitudinally extended carrier-bars attached on the one hand to the anode cylinder and on the other to a metal collar which is received in an annular seating formed within the tube, at or near the point where the extending neck of the tube opens into the bulb; the seating at the respective ends of the tube being of such diameter with respect to the adjacent necks as to present, endwise, oppositely-directed annular shoulders adapted to prevent logitudinal displacements of the plate and its attached supports in either direction after their insertion in position, while lateral displacement is prevented by the engagement of the collars with the inner peripheries of the seatings with which one or both of the collars may be adapted to establish expanding spring contact. The accompanying drawing shows a side elevation of a vacuum tube, illustrating the method of supporting a cylindrical plate therein, a portion of each end of the tube being in section while the filament and its supports are omitted.



Vacuum tube showing method of supporting the cylindrical plate

Secret Radiophone

A FUNDAMENTAL requirement of commercial telephony is there shall be no delay in the transmission of signals, that is, a signal must be transmitted immediately upon its production. This requirement precludes the use of code sending as ordinarily understood, for the secret transmission of intelligence by telephone because such sending would necessarily introduce a delay equal to the time required for translation to code.

In order to accomplish the secret transmission of intelligence, H. W. Nichols proposes to so distort the signal transmitted from the sending station that it shall be unrecognizable at points between the transmitting and receiving stations, but by means of auxiliary modifying apparatus at the receiving station the signal is to be restored to its original character. A fundamental condition for this kind of distortion is that the order of the electrical states which make up the signal shall not be changed, although the intervals elapsing between successive states may be changed in any manner desired. If this condition is not fulfilled, the result will be either delay in transmission of the signal, or else superposition of one part of the signal upon another part, making the signal unintelligible.

In the arrangement shown in the drawing signals are produced by the telephone transmitter, distorted by the apparatus intervening between the transmitter and the antenna, transmitted to the receiving station, received and restored to their original forms and finally translated into audible sounds by the telephone receiver. By further reference to the drawing it will be seen that an iron wire is carried along the face of an electro magnet 3, which is energized by a battery controlled by a microphone, which serves to vary the current through the magnet in accordance with speech vibrations. The result of speech vibrations impressed upon the microphone is to vary the magnetic state of the wire as in the magnetic detector or telgraphone, these magnetic states of the wire being permanent and carried along the wire in its motion to the right.

A second electro magnet shown at 6 is affected inductively by the varying magnetic states of the wire and serves to reproduce the vibrations impressed upon it by the first magnet. There will, therefore, be reproduced in the windings of the second magnet a current which is more or less a faithful copy of the current in the first. The magnet 6 is rigidly connected to an arm, which passes through guides and is driven by a cam mechanism. This cam may be driven by the same source of power as is used for the driving of the iron wire and its mechanism. The purpose of this cam driven magnet, is to so alter the wave form of vibrations induced in it with respect to the vibrations induced in the first magnet as to be unrecognizable when transmitted from the antenna as explained later.

It will be obvious that if the motion of the wire is uniform, and if the two magnets are relatively at rest, the signal induced in the second will be practically an exact copy of that produced by the microphone. On the other hand, if there is relative motion of the magnets, it is, obvious that the signal induced in the last will be distorted, as the time phase relation between succeeding portions of the signal wave will be modified. In designing and operating this cam driven mechanism it is essential that the relative speeds of the magnets shall never be great enough to superimpose one part of the message upon another. In order to efface the message after it has been delivered to the second magnet, and to place the wire into a condition suitable for the recording of a new signal, a permanent magnet is placed below the wire as shown in the figure.

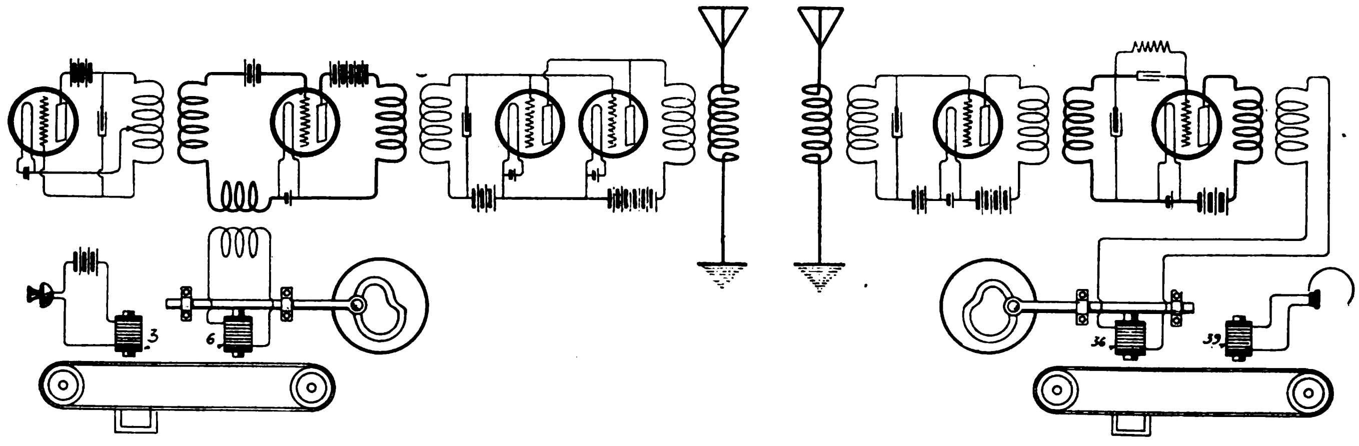


Diagram showing electro magnets and mechanical means for distorting the signal at the transmitter and restoring it at the receiver

The operation of the device is as follows: The distorting devices at the two stations are started in synchronism and in phase by means of a predetermined signal. The cams may be driven by clockwork in order to maintain the necessary degree of synchronism. When a signal is impressed upon the tape by means of the magnet 3 it would normally, if magnets 3 and 6 were at rest and the tape moving uniformly, require a certain definite time to be transmitted to the reproducing magnet 6. If, however, the latter is in motion with respect to the former, the time elapsing between the production of a signal at 3 and its reproduction at 6 will be variable, and therefore the message sent out from the sending antenna will no longer be an exact copy of the impressed message. At the receiving station this message is transmitted to the thermionic elements, being amplified and transformed into low frequency form. It is then impressed upon the receiving magnet 36, whose motion is similar to that of 6. The distorted message is therefore received from the tape in its normal form due to the relative motion of 36 and 39, and reproduced in undistorted form in the receiver.

Improved Condenser Construction

A VERY excellent method of constructing condensers has been developed by Franz Kratz. The salient features of this construction consist of two metal discs placed opposite to each other and having cylinders or pipes protruding inward from their centers, upon which the strips of paper and tinfoil (or whatever the material may be), are wound. In order to obtain a good contact between the metal discs and the two tinfoil strips, these latter are made somewhat wider than the distance between the discs, so that when the winding operation is performed, the one edge of each strip abuts against a disc and is thus caused to coil up and press firmly against it. By the pull exerted on these strips during winding, the discs are prevented from moving apart, so that no rivets, screws, soldering, spring pressure, or any other special means are required to keep the frame together.

Figure 1 represents a section through the condenser, viewed from the side, and figure 2 shows the tinfoil and paper strips as they appear while being wound onto the condenser frame or spool.

Two metal discs or cheeks with protruding ring portions or short pipes are arranged in parallel planes, so that the rings are situated opposite to each other and a certain distance apart. The space between the discs may be bridged by a layer of insulating material, supported by the rings; and upon the roll or spool thus formed the paper and tinfoil strips are wound. The tinfoil strip is made somewhat broader than the distance between the discs so that it is caused to coil up on one edge during winding and is thus pressed firmly against its disc and establishes an intimate contact with the same. By the pressure applied by the tightly wound strips the discs that serve as mountings are prevented from being shifted outward from the middle. This may also be prevented by glueing the rings to the insulation.

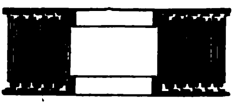


Figure 1

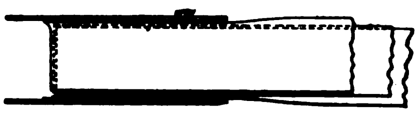


Figure 2

Figure 1—Sectional side view of condenser. Figure 2—Showing tinfoil and paper strips while being wound onto the condenser frame

One of the advantages of this method over other forms of construction is that metal mountings are employed which keep the condenser together without the necessity for any special fixing means, such as rivets.

Another distinct advantage of the condenser is that resulting from the connection of one entire edge of each tinfoil strip to its respective disc and terminal, so that the resistance of the condenser and the inductance which the rolled form of condenser would offer under ordinary methods of construction is eliminated, thus affording a condenser with a low phase angle.

An Amateur Receiver

MANY amateurs will, no doubt, be interested in constructional details and circuit diagrams of a receiver developed by Ernest C. Mignon. Figures 1, 2, 3 and 4, respectively, show the layout of the receiver and the method of control, this last residing in a metallic ring shown in figure 1, as supported on a shaft coming out in the center of the "clover leaf" coil arrangement and being counter-balanced by a weight, and shown in figure 2, where a cross section has been taken through a line of figure 1. In figure 1, it is seen that not only will the metallic ring revolve so as to be concentric with either one of the three coils, but it is also possible to vary the proximity of the metallic ring to the coils, as indicated in figure 2, wherein the ring and its controlling knob are shown in full and also in phantom.

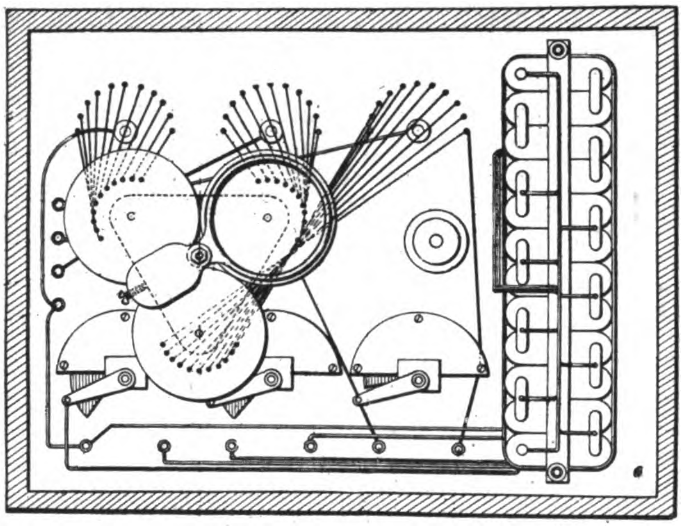


Figure 1—General layout of the new amateur receiver

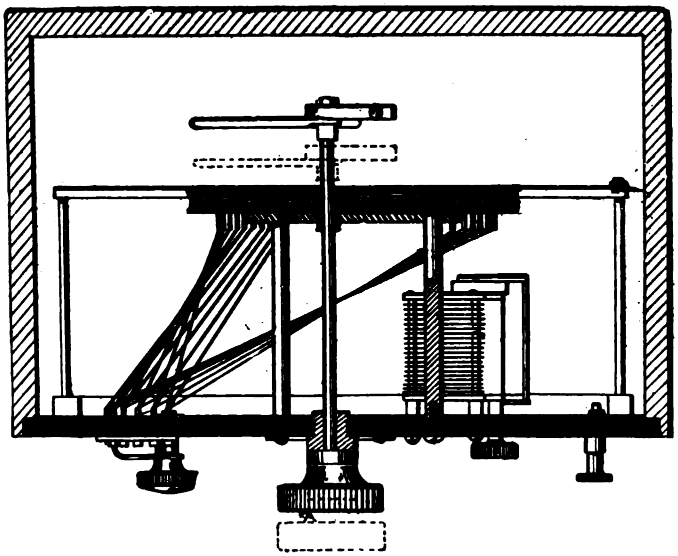


Figure 2—Showing the ring and controlling knob in full and also in phantom

With reference to the circuit diagram, figure 4, it will be seen that the receiver is the usual 3-circuit type; that is, primary, secondary, and plate circuit, and that the coupling between primary, secondary, and plate circuit, in so far as effected by the physical relationship between the coils, is uncontrollable because the coils are fixed in position. The electrical periods of the three circuits are controlled in the usual way, by variation of inductance and capacity. A movement of the metallic ring to a position concentric with any one of the coils will decrease the inductance in that coil. A movement of the metallic ring to such a position that it links any two coils as indicated in figure 3, in all probability reduces the inductance of both coils, to an extent, and slightly further inter-links their magnetic fields.

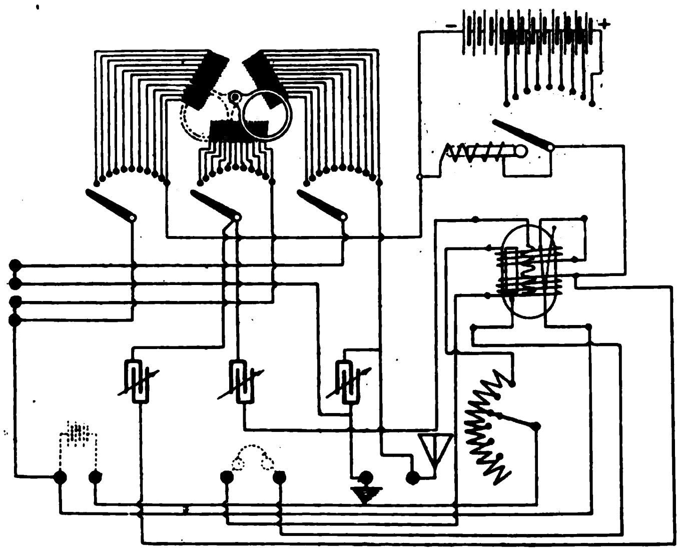


Figure 3—Showing the metallic ring linking two coils

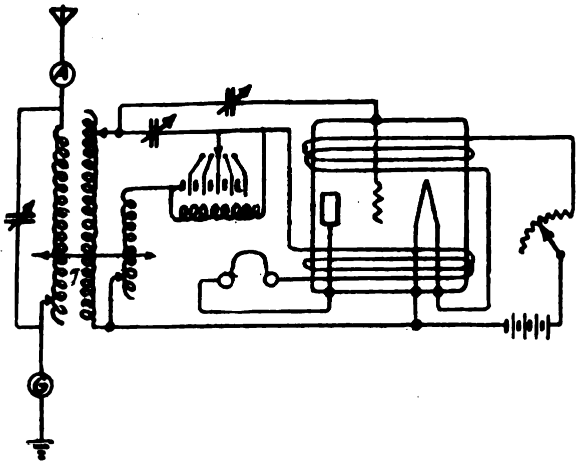


Figure 4—The circuit diagram used shows the receiver to be the usual 3-circuit type, namely: primary, secondary and plate circuit

From a strictly amateur point of view, a receiver design such as this, for use on long wave lengths, might be considered satisfactory, inasmuch as practically all the high power stations may be copied with the device; but from a commercial point of view, the scheme is decidedly impracticable, due to the fact that there exists at all times both electromagnetic and electrostatic coupling between primary, secondary and plate circuits which is uncontrollable, and furthermore it is a well-known fact that the use of a short circuited turn of inductance directly in the field of an inductance will give rise to as much as 50 per cent energy losses under certain conditions.

EXPERIMENTERS' WORLD

Views of readers on subjects and specific problems they would like to have discussed in this department will be appreciated by the Editor

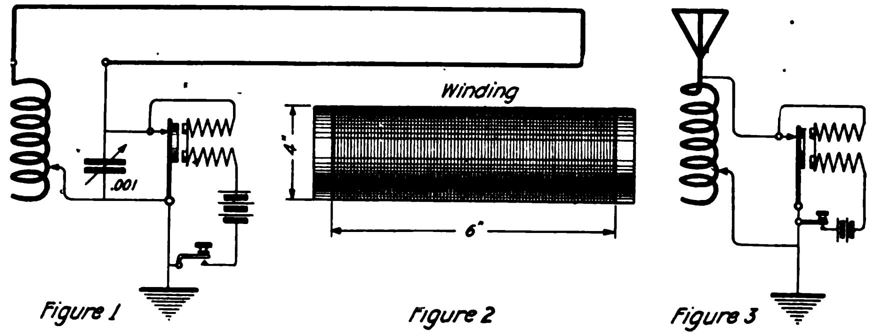
A Low Power Tuned Transmitter for Local Use

By E. T. Jones

THIS is undoubtedly the question of the hour, since it deals with a method which will make amateur operation safer and place it on a sound basis. Amateurs have already caused some little trouble, all of which could have been avoided were it not for the fact that they make use of transmitting sets with power greatly exceeding their needs.

Through accident, I discovered that if inductance of certain value was shunted across the contacts of the buzzer while the antenna and ground connections remained in their usual place, greater distances were covered with the same buzzer and the note of the buzzer was entirely controllable by varying the inductance. Screwing on the contact point and altering the tension of the spring common to the adjustment of buzzers, was thus made unnecessary. All that is required is to have the note of the buzzer (high frequency) adjusted to a pure note and one of very high pitch. It is then connected in the circuit as shown in figure 3.

Here an inductance of the dimensions shown in figure 2 is shunted across the contact points. This was wound with one layer No. 24 SCC magnet wire. A slider is connected as shown. The slider is employed in this case because, with it, greater selectivity can be had. Of course, the units and tens arrangement common to primary windings of receiving transformers can be resorted to.



Circuit diagrams showing hook-up of the high-frequency buzzer and the inductance used in the low power transmitter

With this in mind, I decided to try the arrangement shown in figure 1. A loop antenna measuring 50 ft. long with two No. 18 wires spaced 4 ft. apart, was constructed. This antenna was 35 ft. high at one end and 15 ft. high at the other. I found that it was also possible to effect tuning with a condenser of the commercial type measuring maximum .001 mfd., shunted as shown (across the antenna and inductance). Here it is seen that the antenna is used as part of the shunt, which actually increased the signal strength at the receiving station some 5 miles distant. The series inductance used is the one constructed to shunt the buzzer when it is employed on an ordinary flat top antenna.

This forms a circuit similar to the wavemeter (driver circuit and is undoubtedly *the thing* for amateur local transmission. I am using it exclusively and with vacuum tube receiving apparatus, I am of the opinion that this will transmit 10 or more miles. The greatest distance to date is five miles during mid-day.

With suitable keys, music can be played on this set.

The Submerged Receiving Aerial

By Victor R. Fisher

IN the January 1920 issue of the WIRELESS AGE I noticed an article on "Loop Antennae for Submarines," by Ralph R. Batcher. I have read this article carefully and I think it is somewhat misleading, although I have the greatest respect for the position and occupation of its author. For, relative to this submerged receiving aerial, I have evidence enough to squash the idea.

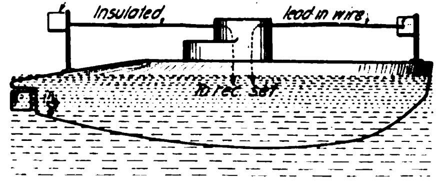


Figure 1—Showing brass plates connected fore and aft and the lead-in wire to receiving set

It was in either August, September, or October, 1916, I believe, that the Navy Department first conceived the idea of putting to actual test the possibility of receiving signals in a submerged vessel. At that time and date I was the radio electrician aboard the DSS K2. The submerging aerial was handed to me while we were still in the Brooklyn Navy Yard, with instructions that I should rig it up when we arrived at New London, Conn. This was in June.

Later, I rigged up this "antenna" which consisted of one brass plate on the after mast (which carried the main two wire aerial), and one brass plate on the foremast. Insulated wires stretched from these plates to amidships, where they entered through a supposedly watertight stuffing box on the conning tower down to the set. The two departmental representatives were Radio Expert Clark, and an aide. On questioning Mr. Clark as to how and why they decided to experiment with this idea, I was told that he had thrown into the Potomac a couple of old wash boilers and pails, and copied NAA, which seemed entirely possible, acknowledging the close proximity of his receiving gear to NAA, which acted on his set via forced oscillations.

He never would have heard NAA had he been 50 miles further away, as experiments proved.

But as to the submarine. After hooking up several thousand dollars worth of audions, amplifiers, and receiving sets (not mentioning the superfluous amount of meters, variable condensers, etc.) the K2 submerged to a depth of 9 feet. The antenna was at the time 3 feet below surface, the submarine trailing behind the USS Tallahassee at a distance of one mile and making a speed of 6 knots. All this time the Tallahassee was sending "dope" out of an American history and caused considerable bewilderment to operators of other ships in the vicinity. We heard . . . nothing.

But just as soon as one plate emerged and the other remained submerged, we could copy NFF, NAH, WDC, and NDC (Tallahassee). We would dive once more and not a sound, and all this wonderful outlay of apparatus. It all proved a fizzle.

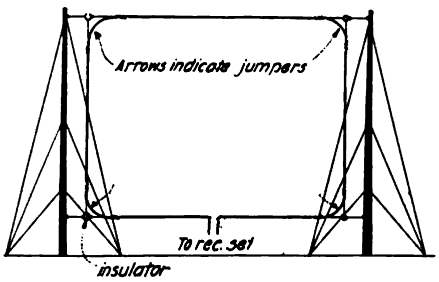


Figure 2—A single-loop antenna without ground used for receiving

During the thirty months of foreign service, I had the good fortune to spend one year at the French trans-Atlantic station YN (Lyons). I had considerable experience there with aerials. We used no ground for receiving, simply one immense loop, 110 feet high, 300 feet long (figure 2). We had three receiving antennae of this same style, and although one of these was situated on a farm a few blocks away, all the receiving sets were in the same room, the lead-ins coming into the room via underground insulated cables.

The most remarkable feat ever accomplished on one aerial, I believe, was accomplished there. We had three receiving stations, one for NSS, one for NFF, and the other for NDD, and the USS George Washington. It so happened that we had a bad ground on one of these out of the way antennae which compelled us to double up on one aerial. In other words, we had to copy NSS and NFF on the same aerial, and without grounds. We kept to this plan, for it was working beautifully, until YN installed his new transmitter. Up to then we had been able to copy NSS and NFF on the same aerial, while YN was transmitting with his alcohol burning arc. But when he received his Alexanderson machine we had to abandon the idea, for he transmitted on very near the same wave as NFF and when one man copied NFF he most likely had decreased the signals from NSS enough to allow YN to break him up altogether. Lyons has a 150-kw machine and radiates 180 when it's working right.

A Successful Undamped Wave Circuit

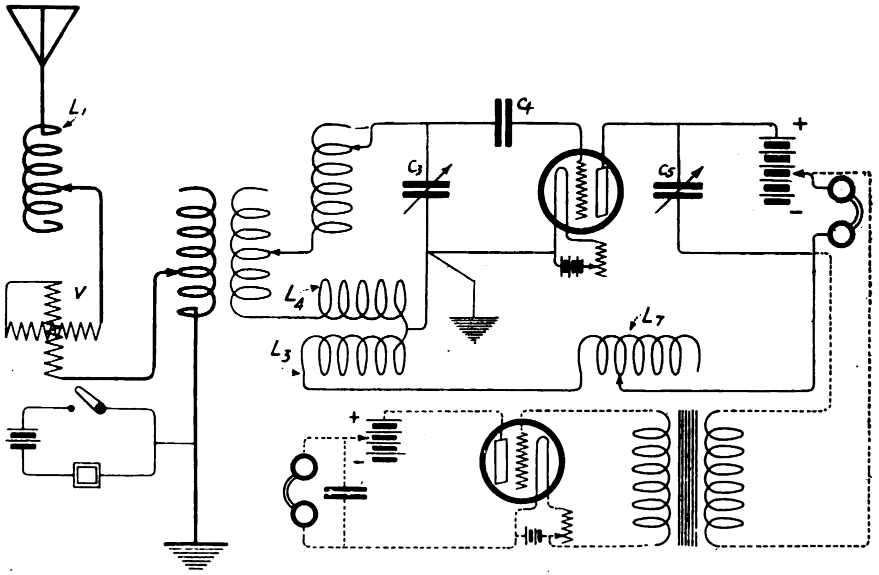
By J. C. Morris, Jr.

An undamped wave circuit with dimensions of the units is supplied by the writer, with the belief that the set outlined possesses many advantages which will be apparent to the amateur. Very long distance records have been obtained with a set of this type, using a small aerial, therefore, it should be suitable for use with the usual amateur. The results obtained will amply repay the trouble and expense of construction.

The following dimensions do not need to be followed precisely, but have been chosen to give a suitable range of wavelength.

The primary and secondary tubes of the coupler are wound with 15 inches of wire. The former is 5½ inches in diameter while the latter is 5 inches in diameter. The primary is wound with No. 24 S.S.C. wire or with bare wire suitably spaced. The secondary is wound with No. 28 S. S. C. wire, taps to the secondary switch being taken off at suitable intervals. The primary is varied with a slider. The writer advocates the use of a slider because of the ease of adjustment. However, to avoid capacitative effects from the body of the operator, the slider should be moved by a handle of at least six inches in length, made of hard rubber or other equally good insulation.

The aerial loading coil L$_1$ should be five or six inches in diameter and thirty inches long, wound closely with No. 25 S.S.C., taps to the multi-point switch being taken every 3 inches or so. Precision adjustment is made by the variometer V. This variometer consists of two cardboard tubes one inch long and 5 and 6 inches in diameter respectively, wound with No. 25 S.S.C., care being taken to keep the same amount of wire on the two coils. The inductance is varied in the usual manner by revolving the inner coil within the outer.



Circuit diagram of undamped wave receiver which can also be used for the reception of long damped waves

The plate and grid loading inductances have identical values, consisting of tubes 5 inches in diameter and thirty inches long, wound closely with No. 28 S.S.C. The inductance may be varied by a suitable slider or by a multi-point switch, taps being taken from the 5, 10, 14, 16, 18, 19, 20, 22, 24, 26, 28, and 30th inch of winding.

The regenerative couplings L$_3$ L$_4$ have fixed values of inductance, but should be constructed so as to have fairly variable couplings. Good results are obtained with both coils 7 inches long, L$_3$ being 5½ inches in diameter, while L$_4$ is 5 inches in diameter. Both coils are wound with No. 28 S.S.C.

Often amateurs can make old couplers function in this position by rewinding same, or suitable variometers are sometimes substituted.

C$_3$ is a variable capacity of maximum value of .0005 mf. C$_4$ is a fixed capacity of .0005 mf. C$_5$ is a variable condenser of .002 mf. (Two .001 mf.

condensers in parallel may be used if desired.)

In use, the primary of the loose coupler covers about ½ of the secondary. L_3 is about ½ way in. L_7 is almost completely used. The other values depend on the wavelength of the received wave. C_3 and C_5 are varied simultaneously.

Attention is called to the filament ground connection.

Filament control is accomplished by means of the battery rheostat. B battery current may be varied either by the potentiometer or by the step by step method. Caution is advised to see that the A battery does not tend to oppose the B battery.

The writer advises bringing the bulb to a sensitive condition by the use of a test buzzer in inductive relation to the ground circuit.

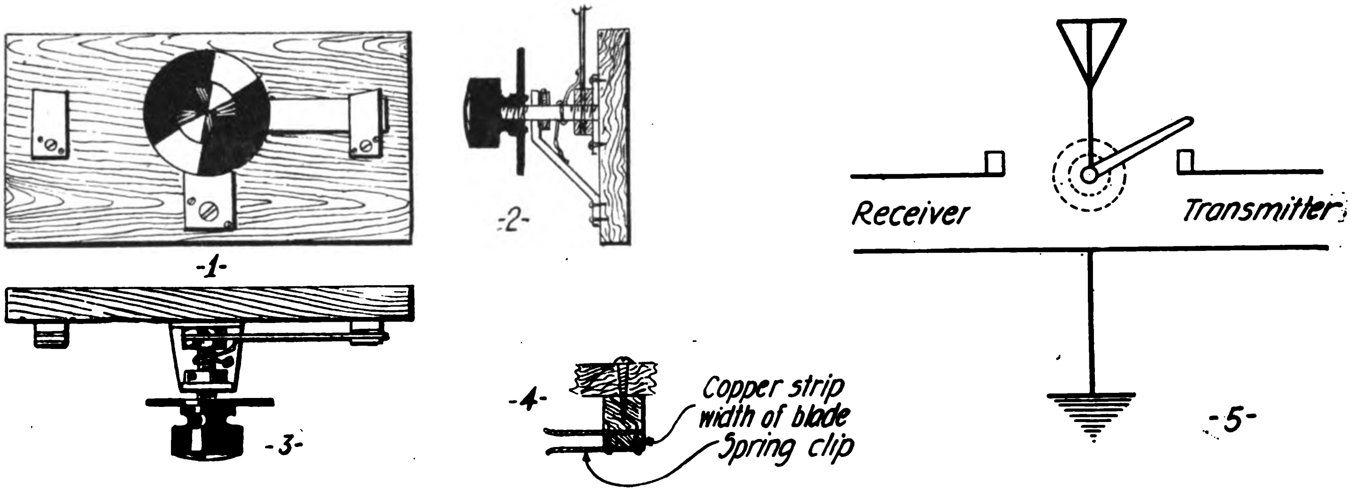
This circuit may be used for the reception of long damped waves.

In order to hear the more distant stations at times, it is advisable to employ a one or two step valve amplifier. The connections of the one step amplifier are shown by the dotted lines. When the amplifier is employed, the phones are removed from the circuit and the primary of the audio frequency iron core transformer is connected in.

An Efficient Aerial Switch

By R. C. Hitchcock

EVERY radio station needs an efficient aerial switch. If its action is quick, snappy, and dependable, it is a great help to good radio communication. The switch here presented has all of these desirable features.



Various views of the improved aerial switch

No provision for the shutting off of low voltage power is provided, as with a careful operator it was found to be unnecessary. The construction is further simplified by eliminating the ground lever. The ground wire is permanently connected to the receiver and transmitter, the aerial being switched from one to the other (see figure 5).

The main lever is about 6″ x 1″ x ⅛″ of heavy copper. A hard rubber shield, and navy knob are mounted on the axle (see figures 2 and 3). The shield prevents the possibility of touching the switch arm, and the use of the large knob makes the throwing of the switch very easy. This navy knob is provided with a brass insert, which is screwed onto the main axle, which is threaded and fitted with nuts, as shown in figure 2. A flexible copper cable is soldered to the switch lever, coiled loosely around the axle, and then led to the copper plate and soldered, thus making positive connection at all times. The clips used may be taken from a large knife-switch, or may be built up, as in figure 4, at the discretion of the constructor. The base may be of hard rubber or of seasoned wood.

Details are clearly shown in the diagrams. Dimensions are omitted, as they vary with the materials on hand. The design should prove satisfactory.

Spark Coil Transmitters

By Albert T. Lynch

USERS of spark coils have in the past overlooked several important factors in designing the installation. A panel spark coil set is more or less difficult to construct, whereas an efficient transmitter requires no panel.

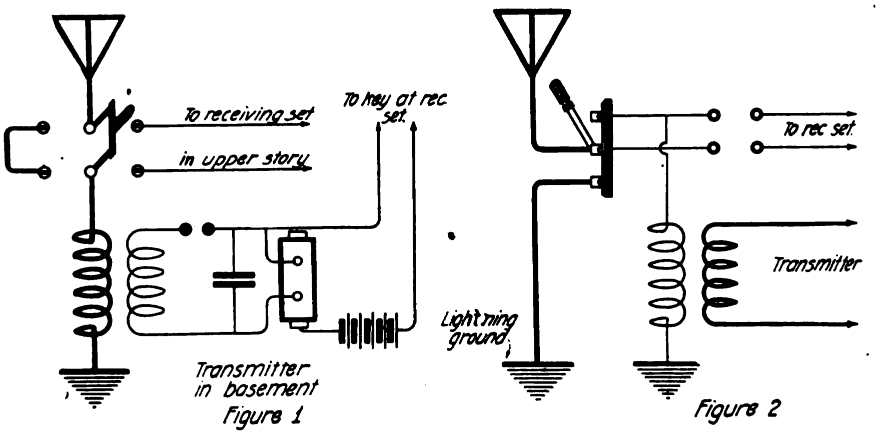
Almost without exception, amateur stations are located some distance from the ground, yet the transmitter, to be truly efficient, should be located close to the ground. This will be apparent on considering the voltage and current nodes and loops in an antenna and closed oscillating circuit. It is a well known fact that in a freely oscillating aerial the voltage loop is at the free end of the aerial, the current loop at the base; in other words, the voltage is low at the ground while the current is at the greatest value.

In the primary closed oscillating circuit the voltage loops are located at the condenser plates, the current loop being at the center of the inductance in the circuit. Hence it is a circuit transference rather than that of voltage which takes place in the oscillation transformer. For maximum results, therefore, the secondary of the oscillation transformer should be connected in that portion of the aerial circuit where the current loop is located, i.e., the ground. Sets so connected have by actual test proven their advantage.

We then can forego the panel set located in the operating room and place the transmitting apparatus in the basement with great advantage. By one stroke we make unnecessary a panel, eliminate the noise and gain efficiency.

With such an arrangement it is hardly necessary to burden the technical press with another design for assembling the apparatus. Mount the instruments compactly in a box fastened to the ceiling of the basement.

using an oscillation transformer for coupling the aerial and closed oscillating circuit. A pair of No. 14 rubber covered wires can be run up through the partitions to enable a key to be located at the operating table for transmitting.



Two circuit diagrams showing the secondary of the oscillation transformer coupled to the ground section of the aerial circuit

The ground lead should run straight to the water pipe or buried wires if pipes are not available. By remembering that the voltage is low and the current high at the ground connection the importance of this part of the installation will be fully realized.

A difficulty is apparently introduced in the matter of switching in the receiving instruments. This can be readily overcome by the insertion of a switch as shown in the accompanying diagram. By mounting the lightning switch so it can be operated by a rod extending through the wall it can also serve as an aerial switch, open for receiving, closed for transmitting.

The transmitter should be carefully adjusted by using a wavemeter and a decremeter. A hot wire ammeter is sometimes very deceptive. The best way is to tune to 200 meters and then get another station to listen in and determine the sharpness of the tuning, loosening the coupling till the wave emitted is clear and sharp. It is well to remember that if the strength of the signal drops to half value by detuning 6 meters on the wavemeter the wave has a decrement of .02 or less. It will be found that a closer coupling can be used with a set located in the basement than one in the upper room of a house with an increase in range.

These paragraphs may cause a state of confusion in the minds of those about to construct a panel set, but it is merely a question of whether the improved appearance of your station is more to be desired than efficiency. Let the amateur decide. Of course he can build a panel set and place it in the basement; or better still, locate his station there with improvement in all respects.

The Vacuum Tube as a Frequency Multiplier

By Clyde J. Fitch

BESIDES being a detector, generator, and amplifier of radio frequency currents, the vacuum tube can also be used as a frequency multiplier. Figure 2 shows a method of tripling the frequency. This method has never been tried by the writer, and is offered only as a suggestion for the experimenter. A sinusoidal alternating current connected to terminals A and B, figure 2, will cause an alternating current of three times the frequency in the circuit L_2C_1, if the tubes are properly adjusted, and the coils L_1 and L_3 are of opposite polarity.

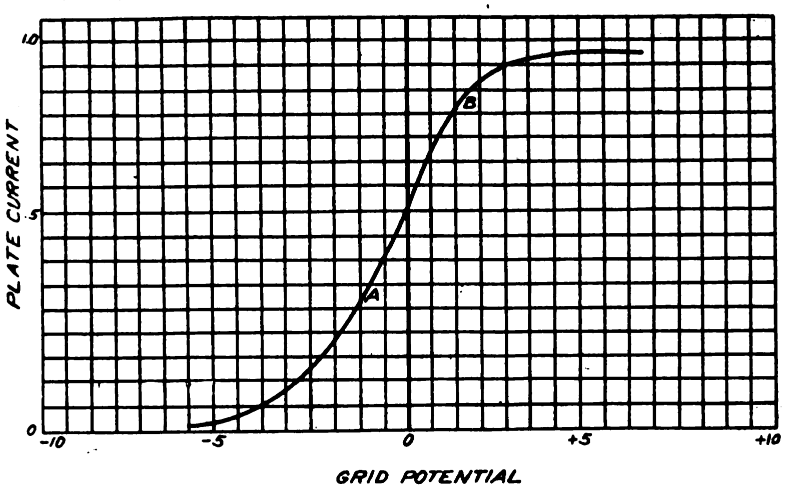


Figure 1—Characteristic curve of the vacuum tube

An explanation can be found from the characteristic curve of the tube, figure 1. The horizontal axis indicates the potential of the grid in respect to the filament, and the vertical axis, the plate current in milliamperes. As the grid potential increases, the plate current at first increases rather slowly, then very rapidly, then less rapidly, and finally becomes constant at the saturation point. By carefully adjusting the filament current and plate potential of tube V_1, we can operate it at the lower bend of the characteristic curve, at A, figure 1, and the plate current through L_3 will be peaked, as in B, figure 3. By adjusting the filament current and plate potential of tube V_2 to operate at the upper bend of the curve at B, figure 1,

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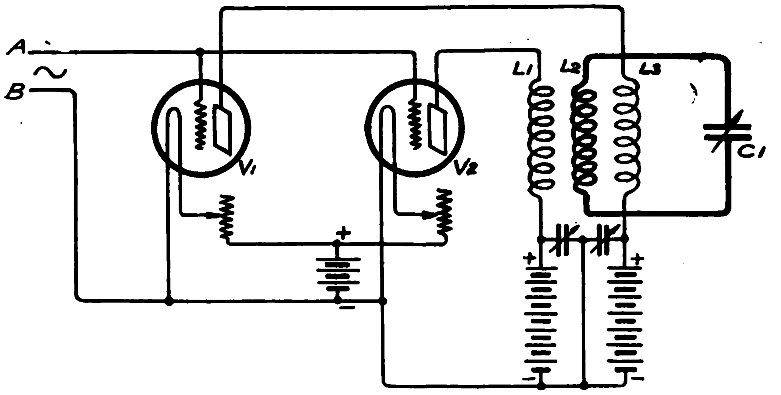


Figure 2—Method of tripling the frequency

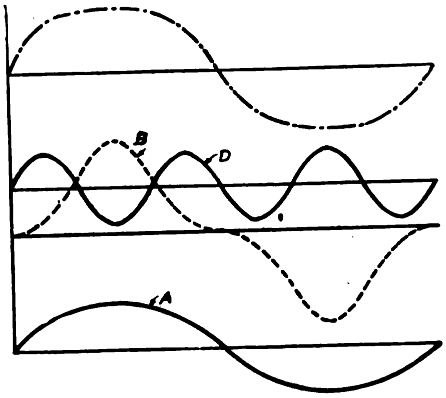


Figure 3—Graphs showing plate current resulting from various adjustments

the plate current through L_1 will be flat topped as indicated by upper curve in figure 3.

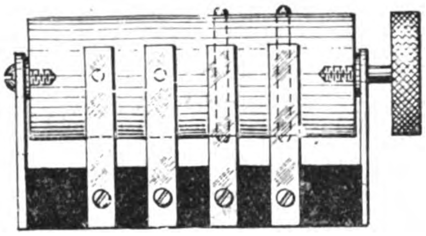
Curves B and C each indicate the presence of a strong harmonic oscillation of three times the fundamental frequency. By connecting coils L_1 and L_3 so they are 180° out of phase, and hence neutralize each other, the fundamental oscillation will disappear, and the harmonic of triple frequency will exist alone. This is shown in curve D, which is obtained by subtracting the ordinates of curve B from those of curve C. Curve D, therefore, represents the resultant current through coils L_1 and L_3 and will induce a similar current in the tuned circuit L_2C_1. Curve A represents the alternating current connected to terminals A and B, figure 2.

Circuit-Changing Switch for Receiving Sets

By Arno A. Kluge

FOR changing various connections in the receiving set when different circuits are being tried, it is often desirable to have a switch that will accomplish this in one operation, instead of using a number of separate switches. Telephone cam switches are commonly employed for this purpose, but these sometimes introduce capacity effects that are unwelcome, and are rather expensive for the amateur of limited means.

The switch here described is not open to these objections, as it has very small capacity effect and may be constructed of the simplest materials at slight cost. It consists of a rod of bakelite or well-seasoned hardwood, about one inch in diameter, mounted to turn just above a rectangular block of the same material. The bearings for the rod are provided with machine screws threaded into each end, holes ¼ inch deep being drilled for the screws. The bearing supports are made of 1/16 inch brass strips screwed to the ends of the base block.



Complete switch with four pairs of springs

A series of contact springs touching the sides of the rod are mounted on each side of the base block, and the connections between different sets of these springs are established by means of conductors running through the rod. These conductors are made of ⅛ inch copper or brass rod, forced into holes drilled for that purpose, and projecting 1/16 inch on each side. It will be noted that one pair is at right angles to the other pair, so that the connections are changed by turning the rod through 90°. The contact springs are made of No. 28 phosphor bronze or brass, ¼ inch wide. The accompanying drawing shows a complete switch with four pairs of springs, but any number required may be used.

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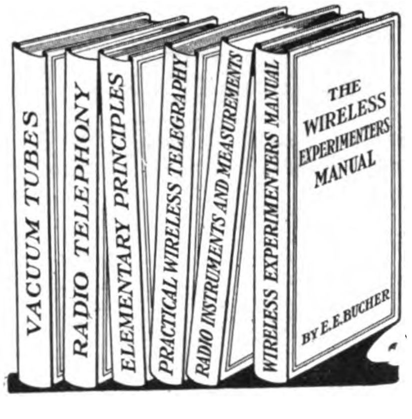
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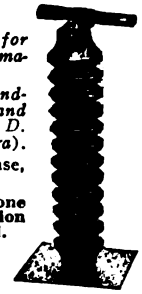

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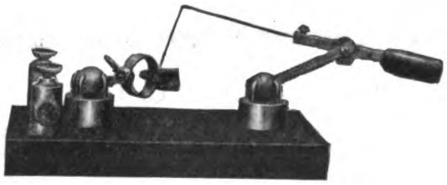
A Simple and Ready-Made Aerial

By C. L. Allen

THE cartoon showing the city fisherman with all his fancy tackle but with no fish, and the typical country lad with almost no tackle, but with plenty of fish, is familiar to everyone. Perhaps the average wireless novice is like the country lad in that he has rather meager tackle with which to conduct his wireless experiments. The resemblance ends there, however, for the art of operating wireless apparatus involves a few qualifications not generally encountered in the art of catching fish. No problem is likely to cause as much hesitation, next to the financial one, as that of the aerial. The novice no sooner reads that the "longer and higher the aerial the better" than he longs for a couple of skyscrapers to stretch his wires between. However, he turns over a page only to learn that someone has actually buried the aerial in the ground—it's no longer an aerial. The novice may accept these statements, but he doesn't understand them. Such extremes are too much for a beginner, and it is as much of a mystery to him as the latest fashions showing women wearing furs in summer and socks instead of stockings in winter.

In selecting the proper type of aerial, therefore, the beginner will perhaps do well to compromise on a happy medium, especially if his purse is inversely proportional to his ambition.

The writer, being affected with the usual beginner's troubles and in addition being, paradoxically, lazy as well as ambitious, began by looking about for a "ready made" aerial. After debating several schemes and trying others he found a possible solution of the problem in the common down-spout and tin gutter of his house. The spout was of copper and the gutter of tin, both of good size, and the latter not over thirty feet from the ground, but extending completely about the house. A wire was soldered to the spout near the bottom and led into the house, with a jack knife switch placed



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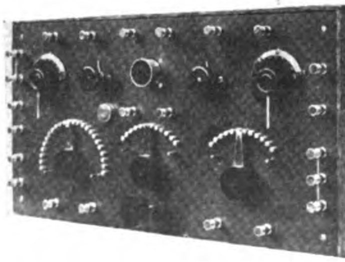

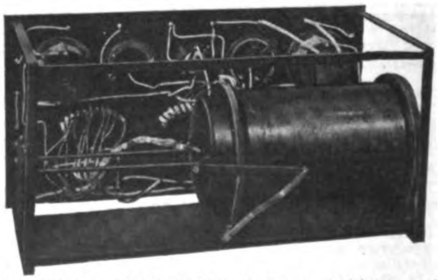

in the circuit between the spout and the instruments.

Two grounds were available at pleasure by means of a two-point switch, one on the water pipe and the other on the gas main, the latter at the point where it entered the house from the street.

This "ready made" aerial—found on practically every dwelling, however humble or elaborate—actually offers the novice something for nothing and, aside from the moment consumed in soldering the connecting wire, involves no expenditure of time or labor. If in a given case it does not give desired results, it might be kept in mind that height is really of consequence, and a "three decker" dwelling is preferable to the bungalow type.

The arrangement offers no added danger from lightning, does not need any ground switch, is not liable to be blown down by storms and is not conspicuous before the general public.

With a tuning coil, a simple detector-condenser and a pair of four dollar 2000-ohm receivers, the writer began the job of "listening in." No fisherman ever waited for a bite with greater eagerness or with less results. However, after much trying of this and that, until patience had ceased to be a virtue, one evening, "while I nodded, nearly napping, suddenly there came a tapping, as of someone gently rapping"—and, behold! NAF (Newport, R. I.) made its first recognized entry.

There is something about hearing one's first wireless signal that is a reward for all the work and time that has gone before; like the boy's first rifle it may be a pretty slim affair but it's real, and it's his. What further joys the reading and grasping of a complete message might bring, the writer could then only surmise, for his knowledge of the code was very limited.

One of the biggest fish in the wireless pond is the time signal sent out by high-power stations, and since it calls

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for no knowledge of the code it is not so very difficult to angle for. However, the wireless sets usually described as suitable for time signal reception are somewhat more elaborate than the simple outfit already mentioned, and the aerials are "longer and higher." It was only by chance, therefore, that the writer was listening in late one evening, and it was only a childish desire to see the wheels go 'round that made him push the slider much further along the coil than usual, which accidentally put the receiver in tune with NAA (Arlington, or Radio, Va.) Signals came in on his tin gutter aerial, located in New England. The signals did not come in like the boom of a cannon, nor even like those of the "buzzer," but they were audible.

Subsequent trials were disappointing, especially in the daytime, and so a loose coupler was substituted for the coil and several crystal detectors were also tried. Crystal detectors remind one of the old adage "when she will she will, and when she won't she won't, and there's an end on 't." Doubtless other detectors are equally guilty. Fortunately there is nothing bigamous about having more than one detector; in fact, there seems to be safety in numbers, although two will answer nicely and also reduce the expense. The detector is the very heart of the apparatus, the *sine qua non* of the whole, yet the most satisfactory detector the writer has used to date cost about two dollars and was of a simple vertical type with a ball and socket adjustment, the galena crystal enclosed in glass, and the whole looking more like a tiny lantern than anything else. With this equipment the reception of signals at night could be depended upon fairly well, although some nights were better than others. With the approaching summer they grew weaker. The aerial apparently worked equally well during rain or sunshine.

Having tried a much-advertised amplifying device without getting the desired results, I experimented with a pair of high-priced receivers of novel design, acquired from a fellow "bug." After repeated trials no appreciable improvement was noticed and added respect was acquired for the cheaper telephones which were apparently giving results out of all proportion to their cost.

With a pair of ordinary wireless receivers bridged across a fixed condenser and with a good detector and loose coupler many of the long winter evenings will not seem so long, even in these dry times, and the total cost need not exceed ten or fifteen dollars.

By getting a book on first principles of wireless, any Tom, Dick or Harry can learn to manipulate a set and secure results. Experience is the best instructor. Moreover, the wireless telephone is already knocking at the door and will in all probability be in regular use ere long. The novice can then entertain the whole family whether they know any code or not.

Prize Contest

The next Prize Contest Subject is:

"The Design and Construction of a Simple Wavemeter, Range 150 to 300 Meters."

Those designs which are built around any one of the standard type of condensers obtainable on the market will be given preference. The data should include a calibration curve for the instrument.

The prize-winning articles will be published in the June issue.
Closing date, April 17th.

Contestants for the prizes are requested to submit articles at the earliest practicable date.

To one who pays frequent visits to the stations of his amateur friends, it is surprising to note the absence in the majority of these, of any form of wavemeter. A wavemeter is a very simple thing. It is also an extremely useful device and the simplicity of its construction, together with its usefulness, should be sufficient incentive for every amateur to construct one.

PRIZE CONTEST CONDITIONS—Manuscripts on the subject announced above are judged by the Editors of The Wireless Age from the viewpoint of the ingeniousness of the idea presented, its practicability and general utility, originality, and clearness in the description. Literary ability is not needed, but neatness in manuscript and drawing is taken into account. Finished drawings are not required, sketches will do. The contest is open to everybody. The closing date is given in the above announcement. The Wireless Age will award the following prizes: First Prize, $10.00; Second Prize, $5.00; Third Prize, $3.00; *in addition to the regular space rates paid for technical articles.*

All manuscripts should be addressed to the Contest Editor of The Wireless Age.

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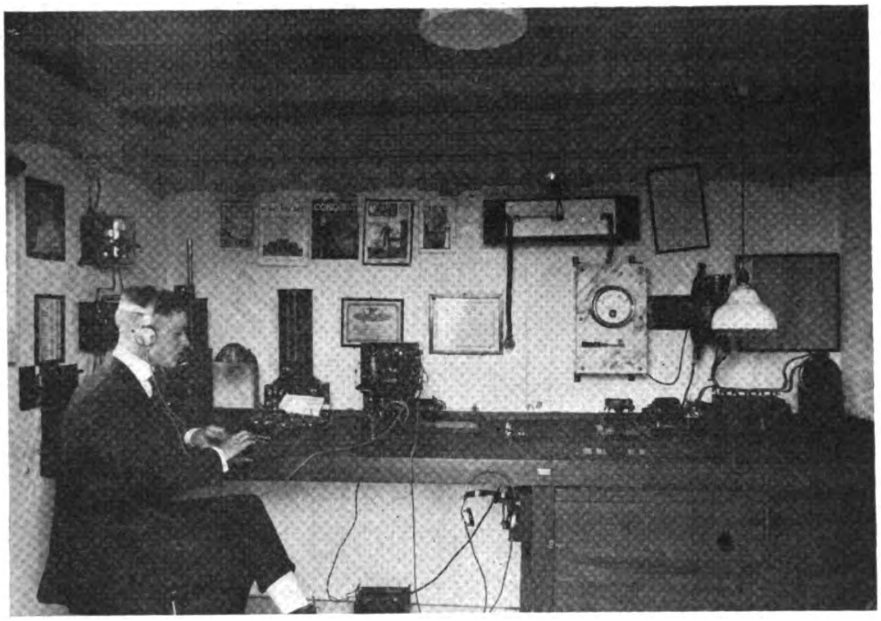
5AP in Texas

STATION 5AP, illustrated in the accompanying photograph, is the property of Raymond L. White, of Ennis, Texas, and is located three miles from the city of Ennis, at the Lake Side Country Club.

The station is a one-room boxed building, and is something similar to the radio cabin found on boat deck of the average ocean going liner. It is situated at the end of one of the 60-foot masts, and a six-wire inverted L antenna is employed. There are no buildings or obstructions near, and when the station is fully completed some very efficient work is expected. In location it is something similar to that of 9ZN.

The transmitter consists of a 1 k.w. Thordarson transformer having a secondary voltage of 24,000, twelve Murdock moulded condensers with a capacity of .0017 mfd. each, connected in series parallel (seven condensers and one rack missing), Murdock non-synchronous rotary gap. The oscillatory transformer is made of 1" x 1/16" brass ribbon and mounted as shown, the hot-wire ammeter is just to the left of the oscillatory transformer mounted on the marble slab; the necessary connections for the transmitter are of copper braid 1 1/16" in width.



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The receiver consists of a navy type loose-coupler (short wave regenerative receiver coming). The arc receiver has a wave length of 300 to 18,000 meters.

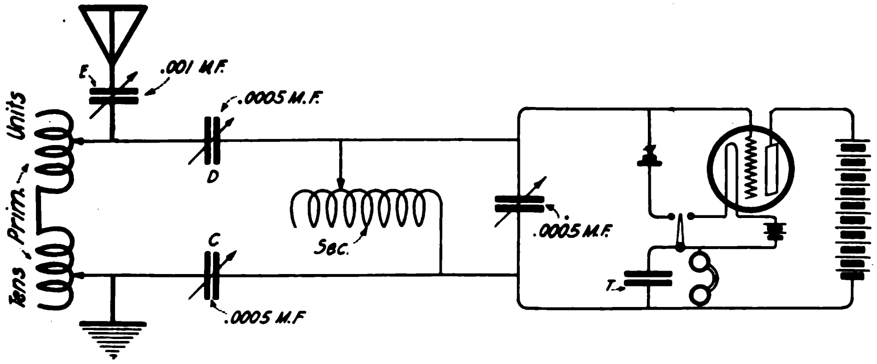
The installation of a short wave regenerative receiver has since been effected. Stations on 425 meters (special amateurs) and 600 meters come in exceedingly well.

Electrostatic Coupling

R. Newell Turner

IN the majority of cases, descriptions of radio receiving sets which are published in THE WIRELESS AGE and other magazines, refer to electromagnetic coupling.

It appears just a little odd that so few have turned their attention to the electrostatic or capacitive coupling, and I am sure experimenters would be more than repaid if they would investigate it.



Secondary coil should be perpendicular to primary. Condenser "E" may be placed either in series or multiple. It may be omitted entirely, but better to have it as in diagram. Condenser "C," the coupling condenser connected to the ground, may be omitted, but if so, the set will be slightly less selective

I have used the "loose coupler" for some time, but I have now discarded it and have made a receiver with a capacitive coupling which is more satisfactory than I have ever found the inductive coupling to be.

The set is more compact and more rigid because the "loose coupler" is replaced by multi-layer coils which are permanently fixed. The coupling is not only easier and quicker to adjust but more complete and it affects the wave length less than the inductive couplings.

The capacitive coupling is very selective and, in comparative tests, signals came in louder than with the "loose coupler."

The experimenter will find that the condenser bridged across the 'phones may be of much greater capacity than is ordinarily used.

The condenser in the primary circuit could be omitted, but it is valu-

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able for "stiffening the circuit," as Marconi calls it.

One of the coupling condensers, the one connected to the ground, may be omitted, and although the set will be slightly less selective, you will still find it better than any "loose coupler."

In changing from the crystal to vacuum tube, a two point switch is used which closes the filament circuit when it is needed and opens it when the crystal is used. It will be seen that the vacuum tube circuit is regenerative.

Some Recent Amateur Apparatus

By W. H. Kirwan

Before the war I tried to perfect three tuners, one of the 200 meter regenerative type, the other an Arlington tuner efficient on wave lengths from 600 to 3,000 meters, and the other a small 20,000 meter tuner. Success was achieved in designing the coils, but trouble came immediately thereafter because a certain European nation had the idea that it could lick the world and all the amateurs therein. Some will remember that amateur work then stopped for a while. But the original scheme about the three units did not die and all three tuners are perfected. They weigh 2 lbs. each and are about 4" x 4" x 3" in size. The highbrows claimed the tuners were no good, could not possibly work, and said lots of other things that did not in the least discourage this hard-boiled amateur.

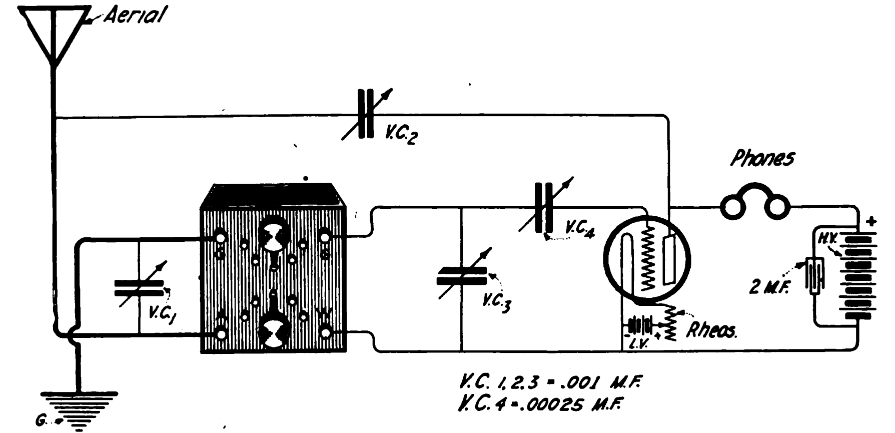

Diagram of the vacuum tube circuit used with the three tuners of 200, 600-3,000, 4,000-20,000 meters range respectively

This type of tuner is wound with 800 turns of No. 28 enameled, silk covered, or cotton covered wire, all of which were found equally efficient for the primary winding. Taps were not used; instead, a loop of the wire was brought out at 5 equal points, 160 turns apart. It was found that taps caused trouble in shorting adjacent layers. I have wound the primary coil with this wire, using a lathe for the purpose, and getting what has been called the involute winding, but fair results may be obtained by winding the coils any old way you want to. I have wound the coils so that the wire

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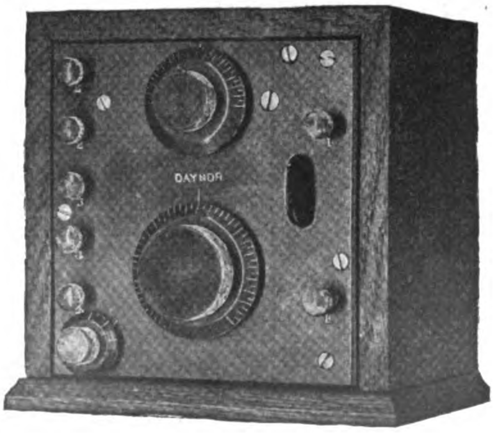

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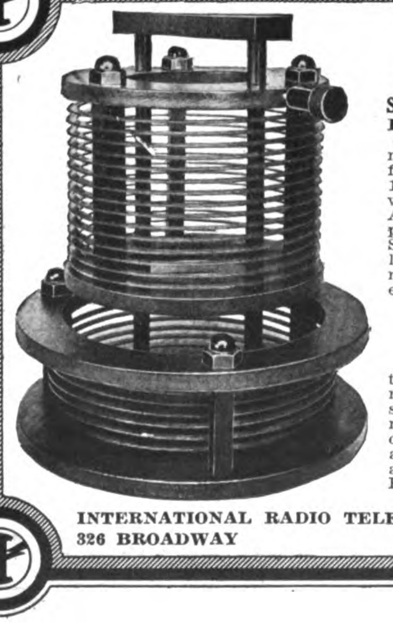
makes 1½ turns and advances across the coil ¾". This makes the pitch of the winding ½". At this point the winding returns to the width of the wire from where it started, crossing the first wire or layer twice. The winding is advanced the thickness of the wire after each 1½ turns, by properly gearing the lathe; it starts back that much quicker from the other end. This makes a coil that is self-contained and needs no outside wrapper to hold it together. Eight hundred turns are wound on a wooden form ¾" wide and 2" inside diameter. This gives an outside diameter of about 3", depending on what kind of wire you use.

The secondary is wound the same way, only the form is ½" larger in diameter; No. 32 wire, enameled, silk or cotton covered; all work equally well. The secondary should have at least 1,200 turns of wire, tapped at 5 equi-distant points and use the loop tap, not the soldered tap. These two coils will then have 6 taps or wires coming from them, the beginning, the end, and 4 taps.

Now you come to the point where no one can help you outside of yourself. Get your vacuum tube circuit ready just exactly like the diagram. Lay the coils along side of each other and test for the position of these coils, where the signals come in the loudest. You may get a signal one way, but the signal is increased by turning the coil end for end. Place these coils in a wooden box about ⅜" stock outside dimensions, 4½" x 4½" x 2¾" without the top. Have the bottom a little larger than sides, and champer off the edge. Take a small piece of paper about 1" x 2", punch 6 holes in it, mark the holes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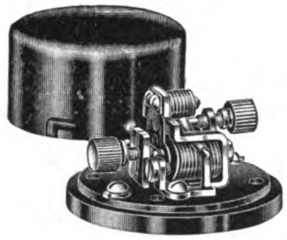

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XDA, the station in Mexico, comes in on his natural tone with the aerial wire connected to the ground terminal and without any ground wire to it at all, merely using the capacity of the body as a ground. I have tried the tuners with the underground aerial, and with the Jones underwater open end coils, and they function equally well, using different hookups, however. Loop aerials also work.

The 2 mfd. condenser across the high voltage battery is optional, but remember that the tuner will only oscillate properly with the aerial and ground wire connected properly with reference to the grid and wing.

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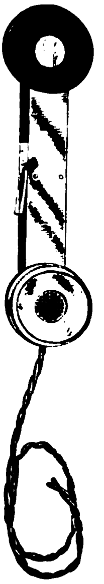

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By THOS. W. BENSON

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Advantage can be taken of this fact to employ a wavemeter without any changes to determine whether the decrement exceeds the limit set by the government. It will be found that at 200 meters, detuning 6 meters will not weaken the signal to less than half its intensity if the decrement is .2 or less.

Thus, when a detector and phones are employed, the decrement of a transmitter can be found roughly by placing the wavemeter quite a distance from the transmitter so the note in the receivers at its maximum intensity is comfortable, that is, not annoyingly loud. Then detune the wavemeter till the tone has dropped to half its former value. Now determine the wave length at the last setting of the condenser. If the difference between the actual wave length of the transmitter and the wave length giving half-signal intensity is greater than six meters, the decrement is too great. Should it be six meters or less, the decrement is within legal limit. This is a very handy method of checking the sharpness of the emitted wave.

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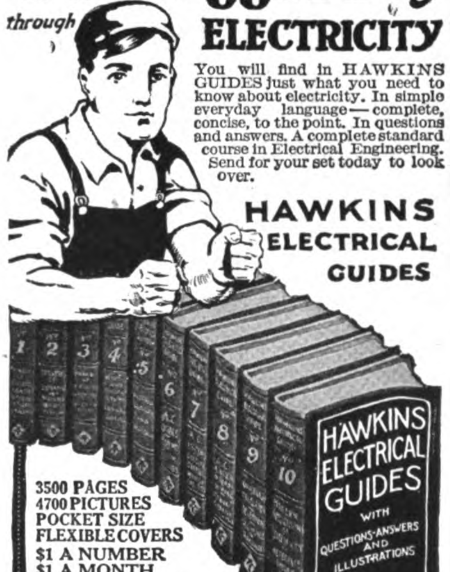
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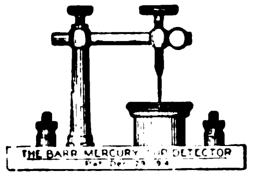

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Instantly adjustable at a constant pressure.

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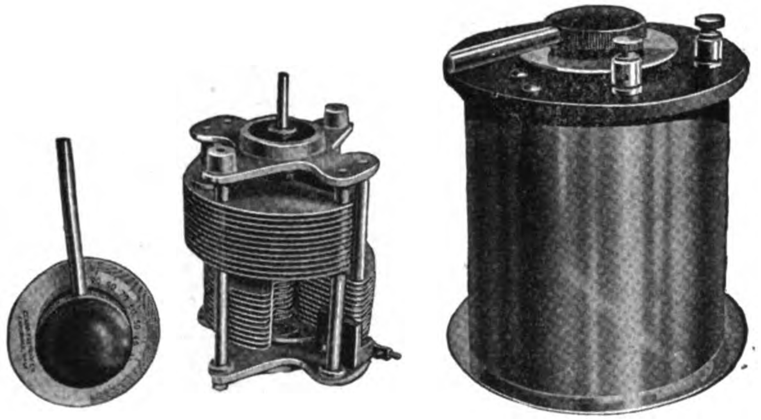

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A C/W 20,000 meter tuner for only $8.00

Wound with the celebrated INVOLUTE coils. The only tuner in the world for amateur use, licensed under Marconi Patent No. 763772, that gets all the European stations with one bulb and one wire aerial anywhere, using no tickler coil. No movable coils, no loose connections, no trouble. Condensers help in the tuning but are not needed to get the arc stations. Only one tuner of each kind sold at this price in each city. Act quick and if you are the second or third we will give the names of those ahead of you.

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Coils for any of our tuners boxed in small container, waxed, tapt, marked and with wiring diagram, for only $6.00.

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Send five cents in stamps for our new catalog, having names and wave lengths of all world stations, wireless alphabet, and International abbreviations. Just off the press.

loosening the coupling between the primary and secondary of the oscillation transformer, thus getting the aerial circuit to oscillate freely at its natural period.

The tuning of a set is often done by means of a hot-wire ammeter but there are certain characteristics of this instrument that lead to short range and poor tuning. An ammeter may often give a high reading while the range of the station and sharpness of the wave is anything but good.

Consider a set emitting a highly damped wave with two humps, as is usually the case. This results from too close coupling between the primary and secondary of the oscillation transformer, permitting the aerial circuit to react on the primary oscillation circuit.

At the receiving station only one of the humps can be tuned to at a time, and only the energy represented in that particular hump will affect the receiver, the energy in the other hump being wasted. But the ammeter at the transmitter will record the current in both humps, which would indicate plenty of power in the aerial circuit, whereas but a portion of it can be utilized at the receiver.

Loosening the coupling and making the wave sharper may reduce the ammeter reading, but the range will be increased. This is due to the fact that the energy is lumped into one hump and has a greater effect on the receiving set. Though the actual current in the antenna is reduced, it is so distributed that it is more effective than the larger current value divided into two, and sometimes more, humps.

Therefore, when the range is out of proportion to the ammeter reading it is not always the fault of the meter nor of the receiving set. Under these conditions, check up the decrement as previously described and it will usually be found to exceed the amount permissible in an efficient set. A broad wave is not only a nuisance in the ether, but it is a waste of power, has a bad effect on the range of transmission and the sure sign of a "Ham."

Apartment House Antenna

THE apartment house has always been a draw-back to the Radio Bug. It is hard to obtain a permit to put up an antenna, and if a permit is obtained, there is always some old woman who is afraid of lightning and will complain to the owner. After which, much to your sorrow, the antenna you put up to stay has to come down. But fear not, there is still a chance, a good chance, of coming into your own.

You have no doubt heard of people using such things as beds, fire escapes, gas fixtures, etc., but when you tried to use them they did not work. Well, here is one that will, and you can sit down and listen-in to your heart's content.

You know when you have visitors and the bell rings, and you or mother run out in the kitchen to press the button so that the ticker on the door will work. Well, that's the secret. All you have to do is to unscrew the button cover and inside you will find two connections. Attach a piece of wire to one of these and connect to the antenna binding post of your set; connect another piece of wire from the water pipe to the ground post of your set, dust off the head set, connect them in—and you can sit back and listen to the music that touches your heart.

A New Club in Brooklyn

AT the first meeting of the Bedford Wireless Association, held in the radio room of the Bedford Y. M. C. A., Brooklyn, N. Y., the following officers were elected: G. Johnson, president, and J. Corcoran, secretary. Two instructors have been secured, Dr. Happe, an all-around radio man, and Mr. Bowie, formerly radio instructor in the U. S. Navy Radio School at Harvard University. They give instruction every Friday night from 8 to 10 p. m. Arrangements are being made for members to visit the big naval wireless stations and those maintained by the different local newspapers.

The club has a receiving set, 15,000 meters, and a transmitter with a motor generator, ½ k.w. transformer, 5 Murdock condensers, a rotary gap and an oscillation transformer.

All those in the Bedford district who are interested in wireless and who would like to join, see or write to Mr. James Corcoran, secretary, 420 Gates avenue, Brooklyn.

Queries Answered

Answers will be given in this department to questions of subscribers, covering the full range of wireless subjects, but only those which relate to the technical phases of the art and which are of general interest to readers will be published here. The subscriber's name and address must be given in all letters and only one side of the paper written on; where diagrams are necessary they must be on a separate sheet and drawn with India ink. Not more than five questions of one reader can be answered in the same issue. To receive attention these rules must be rigidly observed. Positively no Questions Answered by Mail.

F. LaB., California:

The receiving range of your outfit will depend, you understand, upon the power used at the transmitting station. Under good conditions, you should be able to receive from the medium power stations, a distance of 2,000 to 3,000 miles.

Your single wire antenna 35 ft. high and 100 ft. long, will have a fundamental wave length of about 165 meters. The two wire antenna, 25 ft. high and 50 ft. long, spaced 8 ft. apart, will have a fundamental wave length of about 120 meters. The fact that you are using a ground lead 35 ft. long will increase both these wave lengths to some extent.

The Latest Audion Control Cabinet

Here is a compact and highly efficient unit that may be used with any and all receiving circuits.

The GREBE RADIO

Audion Control Cabinet
Type RORH

Price
$17.00
Without Tube

Contains the grid condenser, grid leak, filament rheostat and two 20-volt dry batteries. Socket accommodates the standard 4-prong tube.

There are binding posts for secondary, tickler, phones and filament battery.

Direct and simple connections may be made to all types of receivers.

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The use of a vacuum tube would probably more than double your average receiving range.

We are at a loss to understand your inability to receive San Diego time signals at night when you are able to hear them at noon. It may be possible that the absorption at his wave length is greater under night conditions than under day conditions. This is sometimes the case; instances having been known where communication was possible at, say, 3,000 meters during daylight, and only possible at a much shorter wave length during night time.

From what you have to say about the action of your tuner, we are led to suggest that you procure a good text book on radio telegraphy. Instructions for the proper manipulation of a receiving transformer and explanations of the "reason why" will be given there.

A tin shack underneath your aerial would somewhat reduce its effectiveness.

Another condenser in shunt to your primary winding would increase your wave length, but we suggest the use of additional inductance instead.

* * *

F. B. A., Pennsylvania:

The current which flows through the receivers in a vacuum tube circuit is a pulsating direct current.

Coupling the plate circuit to the grid circuit will produce an alternating radio frequency current in both the grid and wing circuits. A vacuum tube is a repeater. If an impulse is thrown upon the grid of a vacuum tube, the rate of electron flow which is taking place between the plate and filament of this same vacuum tube is changed, due to the change of state of the grid. Now, if the plate circuit is coupled to the grid circuit, any change in the electrical states existing in the plate circuit as a result of impulses thrown upon the grid, will be communicated to the grid, which will in turn disturb the electrical state in the plate circuit a second time, and so on. Thus, if the grid circuit and plate circuit disturbances are properly timed by the tuning of the plate circuit and the grid circuit and by the use of a particular value of coupling between these two circuits, this reflex action will continue indefinitely and the tube is said to be in an oscillating state or to be a generator of oscillations. The frequency of these oscillations depends upon the electrical period of (usually) the grid circuit. The electrical period of the grid circuit in turn is determined by the value of inductance and capacity in this circuit. For ordinary radio work, these values are of such order as to produce frequencies above the range of audibility of the human ear. They, therefore, cannot be heard. If you wish to hear the oscillations of a vacuum tube in your telephones, it will be necessary for you to use inductance and condensers of such size that oscillations are forced to take place at frequencies lower than about 15,000 cycles per second.

The coupling between the wing and grid circuits may consist of resistance, inductance, or capacity. The effect in all three cases is the same. Resistance coupling is seldom used due to the losses which take place in the resistance. Capacitive coupling is often used on account of its simplicity and, perhaps, its convenience: but inductive coupling is usually the most satisfactory, and this is particularly true when amateur wave lengths are being dealt with; capacitive coupling being suitable in every respect only at the longer wave lengths.

* * *

W. O., Indiana:

With reference to the article describing a short wave regenerative receiver in the May, 1919, issue, the loose coupler primary should be 3¾" in diameter and 2½" in length. The size of the secondary should correspond with this.

* * *

C. R. L., Illinois:

It will be necessary for you to secure a license for transmission of any sort, in order to be on the safe side.

* * *

J. A. B., New Hampshire:

With reference to your first hook-up, if you will shunt the telephones and high voltage battery with a condenser of about .001 mfd., oscillations will be more easily obtained. The fact that your antenna and ground are connected directly across the grid circuit inductance will increase the effective resistance of that circuit to such extent as to make the production of oscillations considerably more difficult; that is, to require abnormally close coupling between the plate and grid circuits.

With reference to your figure 2: If your inductance and capacity are of the proper value, you should have no difficulty in making this work easily at any wave length. Try a variation of your inductance.

Regarding hook-up number 3, if one of your two tubes is to be an oscillator, the efficiency of the outfit cannot be materially increased, if at all, by the use of a radio frequency amplifier tube. You might better use this tube as an audio frequency amplifier.

* * *

F. G. O'B., Nova Scotia:

If you place one of the receivers of your head set on a phonograph horn the volume of the signal received will be very greatly increased, and inasmuch as you are using a three-stage amplifier this should prove suitable for time signals, etc. The resistance of the receiver may be of the usual order, that is, 1,000 to 2,000 ohms.

With reference to the data on your transmitter: Assuming that the dielectric constant on the glass in your condenser is 3, the capacity is approximately .005 mfd. From the data which you have given, the approximate inductance of the primary of the oscillation transformer is 25,000 centimeters. Under these circumstances, your maximum wave length is probably about 445 meters. If you wish to increase your wave length to 600 meters, you may do so by doubling either the capacity or inductance in your closed circuit, and, in all probability, doubling the inductance in the antenna circuit will be sufficient for that circuit.

Your 200 ft. aerial, 80 ft. high with the 3 wires, inverted L, has a fundamental wave length of approximately 375 meters. This antenna should be used for your 600 meter work.

Book Reviews

Airplane Antenna Constants.

In this new paper which the Bureau of Standards has ready for distribution, methods are described for measuring the capacity, inductance, resistance, and natural wave length; also the directional transmitting effect of airplane antennas, when the plane is flying. Using these methods results obtained upon various forms of fixed antenna, as well as with one, two, and four trailing wires, are recorded.

Selenium Cells and How They Are Made. By Samuel Wein. The Progress Publishing Co.

This book should be welcomed by those who would like to carry out some of the extremely interesting experimental work which is possible with selenium cells. The publication gives a concise chronological review of the history and development of selenium cells, as well as some very practical data on their construction.

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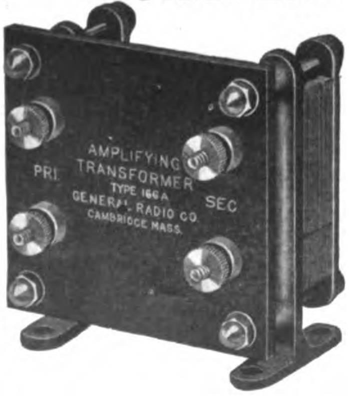
Type 166A



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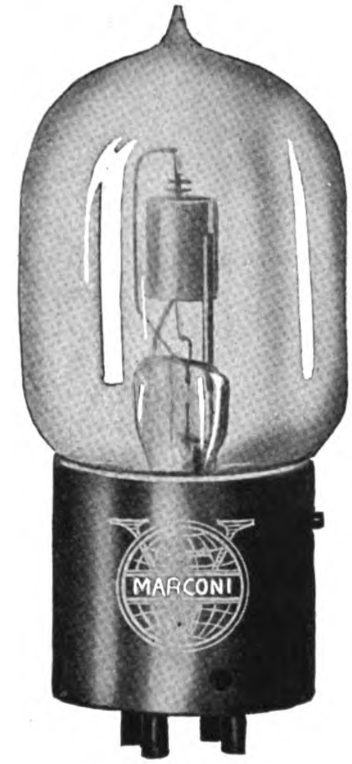

Fleming Pat. No. 803,684
De Forest Pat. Nos. 841,387-879,532

A WARNING

to Manufacturers
Importers
Dealers
Jobbers
Agents
Amateurs
Purchasers
Users of

Vacuum Tubes

The Marconi V.T. Patent is Basic

United States Letters Patent to Fleming, No. 803,684, November 7, 1905, has been held to be valid by Judge Mayer of the United States District Court for the Southern District of New York, and by the United States Circuit Court of Appeals for the Second Circuit.

It is a basic patent and controls broadly all vacuum tubes used as detectors, amplifiers or oscillions in radio work.

No one is authorized to make, sell, import or use such tubes for radio purposes, other than the owners of the patent and licensees thereunder. Any others making, selling, importing or using them alone or in combination with other devices, infringe upon the Fleming patent and are liable to a suit for injunction, damages and profits. And they will be prosecuted.

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Do not take chances by making, importing, selling, purchasing or using vacuum tubes for radio purposes not licensed under the Fleming patent. By selling, purchasing or using licensed tubes for radio purposes you secure protection under the Fleming patent and avoid the risk of litigation for infringement thereof.

This warning is given so that the trade and public may know the facts and be governed accordingly.

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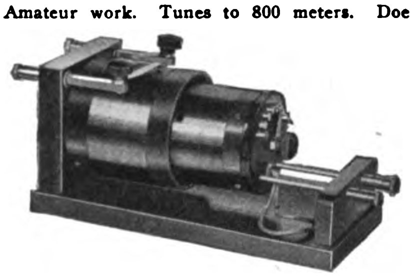

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L-100	450-1460	1.70	LL100	1.76
L-150	660-2200	1.80	LL150	2.16
L-200	860-2850	1.90	LL200	2.28
L-250	1120-4000	2.00	LL250	2.50
L-300	1340-4800	$2.10	LL300	$2.66
L-400	1860-6300	2.25	LL400	3.10
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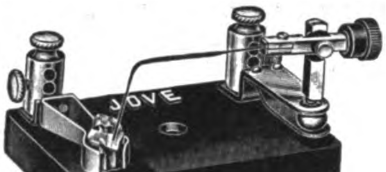

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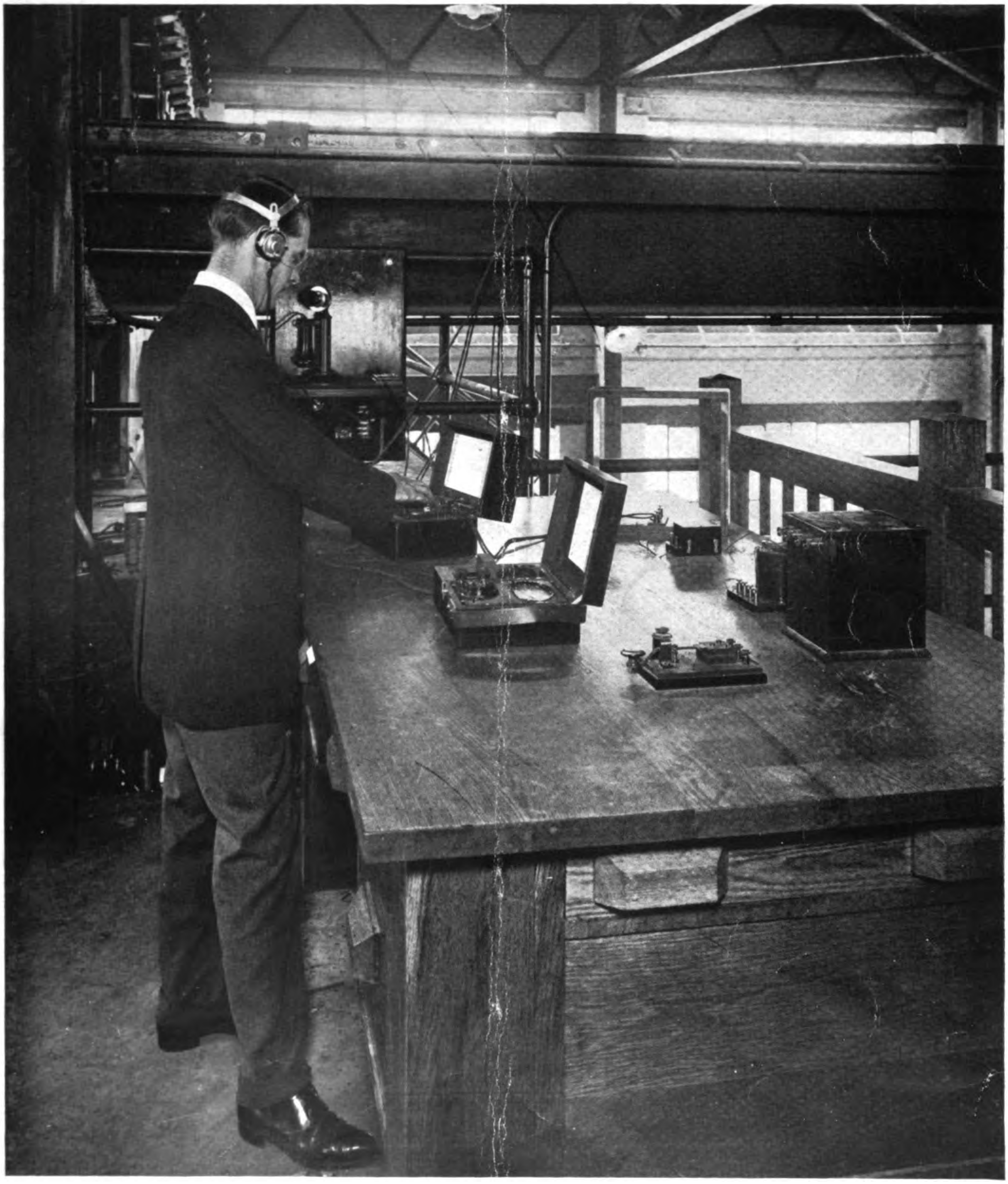
The WIRELESS AGE

Volume 7 Number 7



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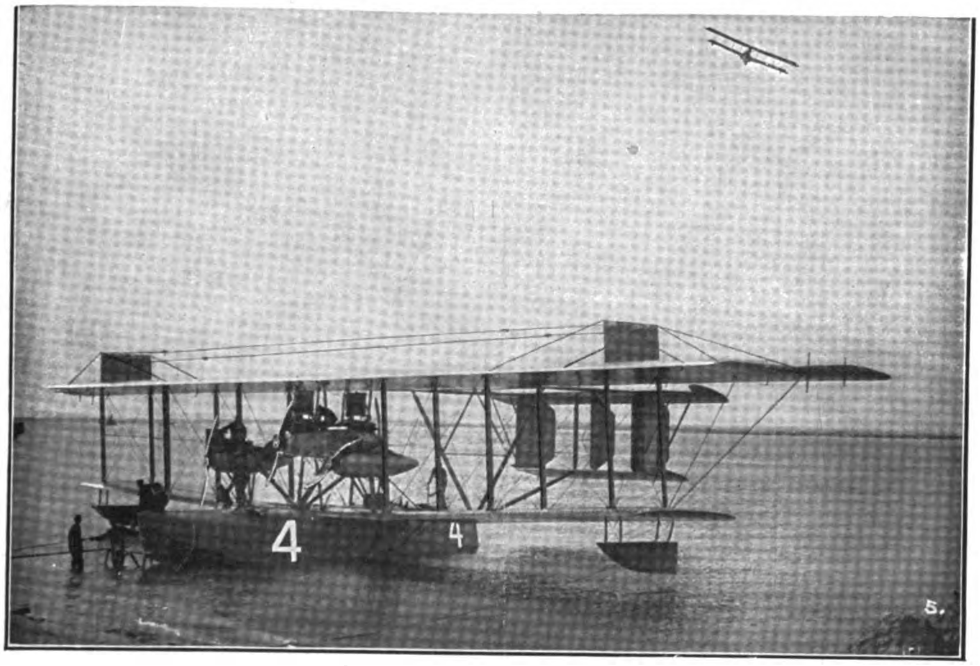
Extract from New York World. June 3. 1919.



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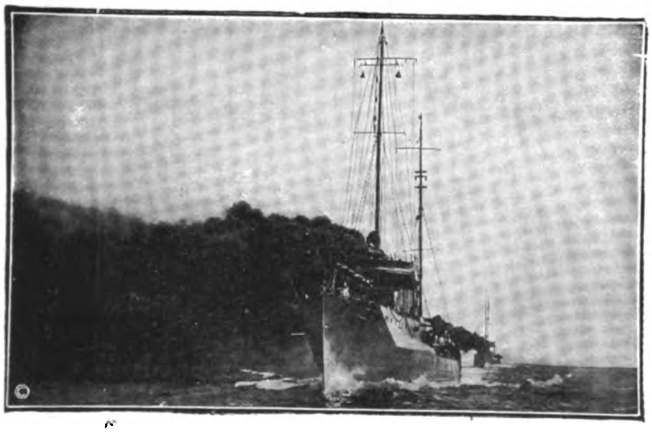

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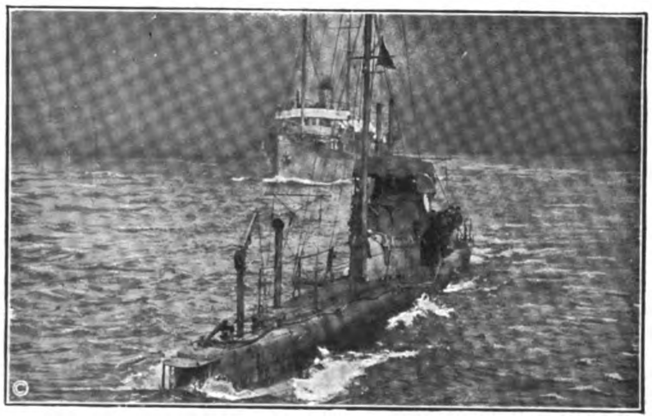

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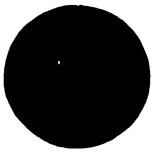

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Edited by J. ANDREW WHITE

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Owing to the fact that certain statements and expressions of opinion from correspondents and others appearing in these columns from time to time may be found to be the subject of controversy in scientific circles and in the courts, either now or in the future, and to sometimes involve questions of priority of invention and the comparative merits of apparatus employed in wireless signaling, the owners and publishers of this magazine positively and emphatically disclaim any privity or responsibility for any statements of opinion or partisan expressions if such should at any time appear herein.

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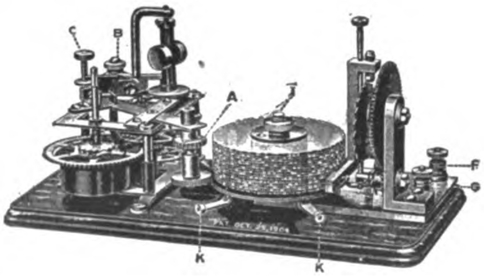

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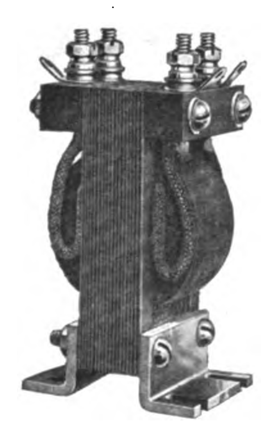

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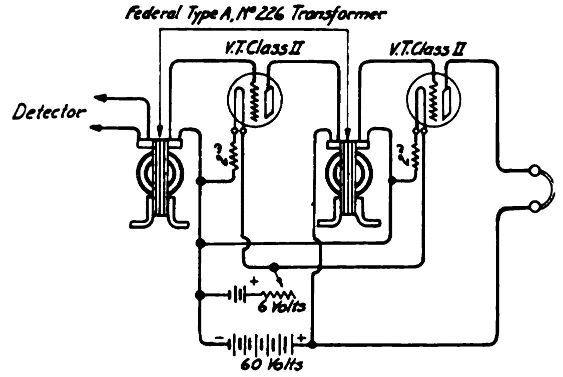

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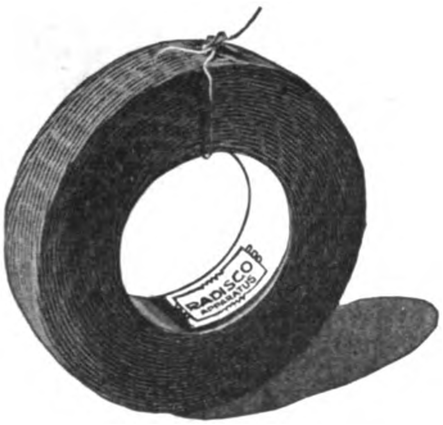

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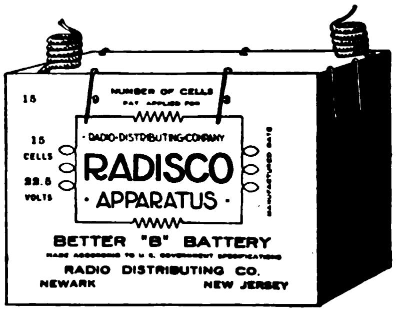

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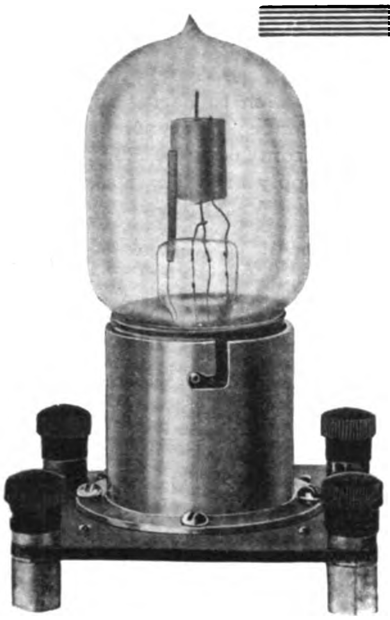

WHEN the Marconi-Deforest patent arrangement was first entered into, whereby the Moorhead - Deforest - Marconi V. T. was put on the market, the Wireless Improvement Company purchased the first large supply in order to get the pick of the limited quantity originally acquired by the Marconi Company.

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If this page is cut out and appended to the same page cut from the editions to follow, a complete file of very interesting information will soon be available. (No. 4)

Vol. 7. No. 7. April, 1920

THE WIRELESS AGE

WORLD WIDE WIRELESS

China Adopts Radiophone Between Cities

CHINA, that land of oriental apathy, which has been asleep for centuries while other nations have moved forward in the march of progress, has beaten the world in the adoption of one modern idea. Guglielmo Marconi calls attention to the fact that China is first among the nations to adopt wireless telephones to carry on communication between cities and rural districts. However, Marconi predicts that wireless phones will within a year supplant the present kind in many lands and that they will be given the widest use in the United States, which, he says, heads the list of nations in wireless inventions.

The wireless telephone has limitless possibilities and should be a great advance step over the present cumbersome system, which requires an enormous amount of work to keep up and at a tremendous expense.

Chinese Government to Establish High Power Stations

IT is reported that the English Marconi Company is making arrangements with the Chinese Government to establish high power stations in Pekin, Urga, Urumohi and Kashgar, which will be able to communicate day and night with the Indian Government station of Simla. There also are to be subsidiary stations in Uliassutai, Kobda, Sianfu and Hami. It seems evident that well informed people feel that these trade routes are of very great importance. If a railway is to be constructed from Kalgan through Urga to connect with the Trans-Siberian, and the old routes to India are to be reopened, the situation in eastern Asia will be materially affected.

Wireless Service for Mexican Border Patrol

IN order to reduce the danger of American Air Service pilots accidentally flying over Mexican territory or becoming lost while on border patrol duty, the commander of the 91st Aero Squadron stationed temporarily at Ream Field, Imperial Beach, Cal., has had every plane of the squadron equipped with a radio set with a wave length of 377 metres, which is the best wave length to dodge interference. All pilots are required to check their position every five minutes.

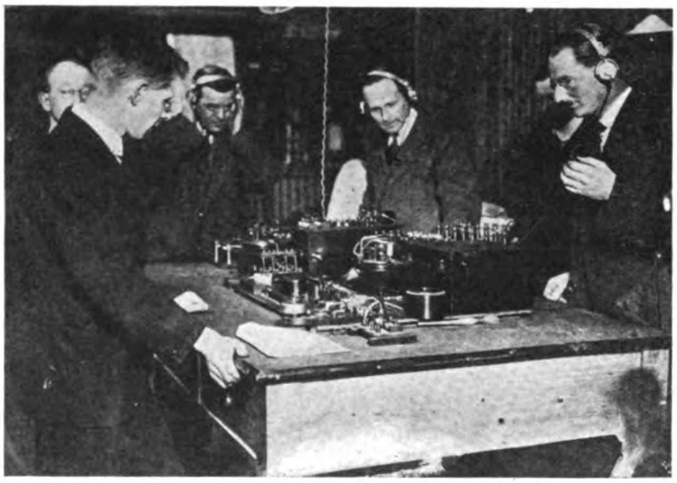
As a further precaution the radio officer of the 91st Squadron has erected at Ream Field a radio compass station by which readings are taken while planes are sending in their position reports. As the course is almost straight east from Ream Field the radio officer can tell almost instantly whether a given plane is holding to its proper air line.

Should a pilot become confused, lose or mistake his position and turn south, the radio compass would immediately show that the plane was over Mexican territory.

1500-Mile Radiophone Message at Sea a Surprise

NEWCOMB CARLTON, President of the Western Union Telegraph Company, returning from a vacation in England on the steamship Baltic, said that on the trip the wireless operator of the vessel afforded him an opportunity to hear a voice over the wireless telephone from a distance of 1,500 miles. There was some slight interference, but Mr. Carlton was greatly impressed by the experience.

Speaking of the wireless, he said it would not supplant the cables, but would be a valuable service to commerce.



(Underwood & Underwood)

Demonstrating the operation of the new wireless bell device with which it is intended to displace the S O S distress signal at sea

England Receives Wireless Offer From Marconi

THE British Government has received an offer from Guglielmo Marconi to link up the entire British Empire in a chain of wireless communication, the system to be turned over to Government ownership, if desired, at the end of thirty years.

Plan to Detect Mysterious Mars Signals

ORGANIZED tests of the mysterious signals supposed to come from some other planet will be made toward the end of April when Mars reaches the nearest point to the earth, Godfrey Isaacs, director of the English Marconi organization, has announced. All Marconi stations will be instructed to watch out for mysterious messages, he said, adding:

"We will try first to discover whether the sounds are picked up in various parts of the world in the same instant, because, if so, the theory that they are definite messages from another planet will be enormously strengthened."

New York Auto Show Has Radio Tractor

THE radio exhibit at the automobile show, New York, staged by the Signal Corps, presented many interesting features, most important of which probably was the army radio tractor, which was used extensively in the recent war. One company in each field battalion is equipped with this tractor.

The special body housing the equipment, is mounted on a two-ton chassis. The tractor is, in itself, a complete radio station of moderate power. The antenna is of the umbrella type, and is carried with the tractor, while the radio generator is operated with the transmission in neutral. While driving the generator, the speed of the engine is governed by a centrifugal governor.

Tractors of similar type were used in the campaign in Mexico, and were also in service with our forces overseas, and are now used extensively by the troops on the border.

Marquette to Have Wireless Station

THE United States Navy Department means to establish a wireless station at Marquette as a part of a general program for giving added protection to Great Lakes navigation.

A representative of the big station at Great Lakes recently visited Marquette and looked over a site on Presque Isle as a possible location for a wireless station. One acre of land on the northeastern corner of the island is owned by the government, and has been retained for lighthouse purposes. The navy man after inspecting the site said it would be the ideal spot for a wireless station.

Navy to Promote Amateur Wireless in California

PROMOTION of amateur radio plants and the study of radio operations has been undertaken on a big scale by the officers of the Twelfth Naval District, San Francisco, Calif.

Lieutenant Commander S. D. McCaughey, district communication superintendent of the Twelfth Naval District, has sent out a circular letter to all radio amateurs outlining plans for the navy co-operation with them. This will include a press service for amateurs and later a special code for reception of code messages to be broadcast for them by the navy.

Advice and assistance in development of their apparatus and ability of reception will be tendered by the navy officials.

All amateur radio stations in the district, embracing California, Utah, Nevada, Colorado, New Mexico and Arizona, are requested to obtain a "data sheet" from the district communication superintendent, U. S. N., Room 418, Sheldon building, San Francisco.

California has been divided into five leading districts, with an additional sixth district taking in all territory not included in the first five. Each of the California districts is formed by a radius of seventy-five miles from the following navy radio stations. Yerba Buena Island, San Francisco Bay; East San Pedro; Point Loma, San Diego; Table Bluff, Eureka, and Point Arguello, near Point Concepcion.

Within each district the amateurs will hold meetings and establish definite rules and regulations for communication among themselves to conform to the regulations relative to wave length restrictions, 200 meters, and power regulations, one-half of one kilowatt.

Competitive drills in communication will be sent out by the navy stations to determine rank among the amateurs.

London Wireless Inventor Hears Concerts in Italy

A LONDON inventor, H. Powell Rees, has invented a wireless telephone apparatus on which messages from Moscow and concerts in Italy have been heard, although the aerial used is only an 85-foot wire hung outside of his bedroom window, according to a Times copyright cable. The mechanism is contained in a tiny box and the cost of manufacture is said to be small. Messages from American stations are also readable.

New York Central R. R. Radiophone Tests Successful

A WIRELESS telephone conversation was recently carried on for an hour without interruption on the Harlem and Putnam divisions of the New York Central, between Elmsford and Millerton, 78 miles apart. The experiment was made by Maj.-Gen. George O. Squier, signal chief of the United States army. The direction of the waves was guided by the wires strung along the tracks. He was able to speak to and from moving trains and send a number of communications simultaneously.

Moscow Wireless Works Without Stop

THE wireless at Moscow works twenty-four hours a day and grabs practically all the wireless news from America to European countries. Each morning in Moscow bulletins containing this information are printed and distributed in the industries, in the peasant villages and among the soldiers.

Venezuelan Government to Build High Power Station

THE Venezuelan government, up to June 30, will receive bids for the erection of a powerful wireless station to be built near Caracas, which will be of sufficient power to communicate with similar stations in the United States and Europe.

U. S. Forest Service to Use Radiophone

PRELIMINARY tests of the wireless telephone by officers of the Forest Service of the Department of Agriculture, in the vicinity of Portland, Ore., lead to the belief that this invention can be utilized extensively in the national forests, especially in fire-prevention work. The results so far are pronounced satisfactory.

One of the sets in the tests was installed on Mount Hood, Ore., where the problem of providing a satisfactory support for the antennae was a difficult one, since a mast was needed which would be strong enough to resist seventy or eighty mile gales that sweep the mountains. At the same time the mast had to be light enough for the men to be able to raise and lower it before and after sleet storms. A fifty-foot bamboo pole was finally selected as the support.

In the telephone conversation between the sets, some of which were ten miles apart, the voice carried very clearly and was about as loud as over a wire line. Telegraph signals from many stations scattered over the continent were picked up. On Mount Hood they often were so loud as to be audible in any part of the cabin.

Trans-Oceanic Radiophone Service Within Six Months

WIRELESS telephonic communication between England and America has passed beyond the experimental stage.

"Within six months," says Godfrey Isaacs, Managing Director of the English Marconi Company, "we may be speaking to New York, Boston, Chicago and any other towns in the United States more quickly and easily than we are able to communicate with Birmingham or Manchester."

Mr. Isaacs said the cost would only be a few shillings for a three-minute conversation and he added: "In a year or so we hope to establish regular telephonic communication with Australia. We hope to bring every country in the world into telephonic communication with each other—not in an indefinite time, but very soon."

◆

London and Paris Airplane Service Has Radiophone System

ON the regular airplane service now established between London and Paris a system of wireless telephony enables persons on the airships to be in speaking communication with ground stations. The voices are conveyed distinctly and can be identified as readily as if those conversing were face to face. This wireless conversation has been tested over a distance of fifty miles, which is as far as is required in the interval between stations.

◆

Norfolk Police to Use Wireless

REAR ADMIRAL A. C. DILLINGHAM, retired, head of the Norfolk, Va., Police Department, with the title of Director of Public Safety, is working to bring the department up to a state of last-word efficiency through the establishment of an aero squadron and the equipment of the police stations with wireless outfits.

"The wireless," says Admiral Dillingham, "will enable us to get in almost instant touch with the police departments of New York and other great cities when necessity arises."

◆

Saigon, Indo-China, to Have Powerful Station

ADVICES received at the headquarters of the Inter-church World Movement, which is making a religious, economic and social survey of the world, state that the most powerful wireless telegraphic station in the world is being installed at Saigon, Indo-China. This new station will be so powerful that communication may be had with France, Africa, Madagascar, French New Caledonia, Australia, Japan and the United States.

The report explains that the continuous wave system will be used and the electric power will be supplied by two converter groups equipped with internal combustion motors of 2,500 horse power. Aerials will be suspended from a height of 833 feet, nearly 100 feet higher than the Woolworth building, and the network of wires will be spread over nearly 180 acres.

This new station brings the world closer together by many thousands of miles, and it is expected to be of great aid to the Pacific northwest in carrying on transpacific business communications.

Italy and England Connected by Radiophone

WIRELESS telephone communication has been established between England and Rome, the Daily Mail announces.

The distance is more than 2,000 miles.

◆

Denmark and America to Be Connected by Wireless

A DANISH radio commission is proceeding to America on April 8. The commission will negotiate with the American authorities for the linking up of a radio service between the United States and Denmark.

(Underwood & Underwood)

Kansas operator listening to music and conversation from New York transmitted by a radiophone set using a vacuum tube and one-third kw. generator

Bolivia Gets Three New Wireless Stations

THE Ministry of the Government of Bolivia recently accepted a bid made by the Bolivian engineer, Senor Humberto de Asin, to install three wireless stations in the country, to be located at Guayaramerin, Cachuela Esperanza and Trinidad. The Government will contribute the sum of 11,000 bolivianos (boliviano equal to $0.3893 U. S.) for the first, 25,000 bolivianos for the second station, and 75,686 bolivianos for the Trinidad station. These three wireless plants will connect the outlying districts of the republic with the rest of the country.

◆

S. S. Imperator Receives Radio Messages from Scotland Across Atlantic

WITH a new wireless receiving apparatus rigged on her, the liner Imperator arrived from Liverpool recently. All the way across the Atlantic she received radio messages direct from the big station in Aberdeen, Scotland. It was the first time a vessel had been in communication with a single land station on an entire transatlantic trip. The transport George Washington, when she carried President Wilson to France the last time, was in direct communication with this side almost all the way across the Atlantic.

Sir Ernest Glover, Director of the Ship Branch of the British Ministry of Shipping, was a passenger, and was much interested in the wireless feat.

Wireless in the A. E. F.

First Authentic Account of the Organization of the Radio Division of the Signal Corps and an inside View of the Great Obstacles Which Americans Had to Overcome

By Lieut. Col. L. R. Krumm
Officer in Charge of Radio Division, Signal Corps, A. E. F.

and Capt. Willis H. Taylor, Jr.
Co-ordination Officer, Radio Division, Signal Corps, A. E. F.

Part IV—Listening Stations

This listening station was located in a Vosges mountain sector and was operated jointly by the French and Americans

LISTENING stations were a development of trench warfare, so it naturally followed that the credit for the first utilization of the sensitive low frequency vacuum tube in connection with grounded antenna covering a considerable area was variously claimed by the different armies engaged in the war before our entry. Documents published by the Intelligence Service of the British Army indicated that the German army used their stations against them at the first battle of the Marne. Certain it is, that at the end of the war, the Germans were as well informed regarding listening stations as were the Allies.

The information regarding German listening stations published by the British Intelligence Service consisted of captured orders and other data indicating that at the beginning the Germans realized that the effectiveness of listening stations was unlimited, if knowledge of their existence and efficiency could be kept from the enemy. They took extraordinary precautions to keep from their own men—other than those actively engaged in the operation of the stations—knowledge of the existence of these stations. This was the reason why their soldiers, when taken prisoners, could give no hint to the Allies during the usual gruelling cross examination. All the information obtainable indicated that the operators were especially selected and trained for this duty, this personnel being entirely segregated from other troops and special arrangements made for their subsistence and maintenance, making it unnecessary, and in fact, almost impossible, for them to come into contact with the general body of the combat units.

Stories were current of the early days of trench warfare, when in many places the front line trenches were separated by a strip of No Man's Land only fifty yards wide and the necessity for the telephone code was not appreciated, that many an attack came to naught because of information intercepted from telephone lines of both sides by these listening stations. Later, when their use became general in all the armies, the Germans were evidently so impressed by the effectiveness of their own stations that they greatly restricted the use of the telephone in their front lines. The instruments were sealed and their use limited to absolute emergencies; an explanation was required from the breaker of the seal as to the necessity for usage of the telephone.

The interception of T. P. S. messages naturally could not be prevented, and, as with radio, the use of code was compulsory, but even here the Germans attempted to prevent the effective use of our listening stations by employing interfering screens of audio-frequency ground currents, as will be explained later.

Toward the end of the trench warfare operations, listening stations lost a considerable part of their effectiveness because of the general knowledge of their use by all the armies. Possibly the greatest factor in limiting the results obtained by the enemy listening stations in interception of conversations on our lines, however, was the radio section listening stations which acted as monitors of our own circuits. A well insulated and balanced metallic telephone circuit is practically immune against eavesdropping, but such lines were difficult to maintain in quiet sectors and practically impossible in active sectors. Faulty conditions on our own lines were therefore immediately revealed through our listening stations, as well as the transmission of indiscreet messages over leaky or grounded telephone lines. As a result, our telephone circuits were maintained in the best possible condition through the operation of our listening stations against them as well as against those of the enemy. Many an infantry officer reading this article will realize for the first time the source of information upon which was based the reprimand he received for the transmission of an important message in plain English over a telephone.

The use of the listening station was continued in our army up to the last, even in mobile warfare, although conditions were generally unfavorable. The fact that the hastily rearranged and reconstructed telephone lines of the enemy were increasingly defective, compensated somewhat for the difficulties encountered in the operation and maintenance of our stations.

Prior to the development of the listening station, adventurous men in the Allied armies had endeavored to ascertain the enemies' plans by direct tapping of their telephone lines, signalmen crawling across No Man's Land on dark nights to bridge a telephone on the enemies' circuits. But even the advent of the listening station did little to lessen the hazards, and no activity of the Radio Section of the Signal Corps, A. E. F., was more thrilling—and more interesting—than the listening station service.

The radio intercept and radio goniometer service which has been previously described was probably the source of more information, but these stations were usually placed from five to ten kilometers back of the line, in locations of comparative safety. In quiet sectors, and during the first months of our army's operations in France, this class of stations took on to some extent the humdrum character of a commercial receiving station. But the listening stations located in dugouts in or near the front trenches were never without excitement, nor were the personnel assigned to them permitted by the enemy to forget that they were actively participating in a war.

While the function of the stations and the duties of the operators were limited in possibilities, life in a listening station never became monotonous or lost its fascination. Thus the listening service became the goal of every member of the Radio Section who craved action and adventure. However, the qualifications necessary for service in listening stations were more than ordinarily diversified. The first essential was a thorough familiarity with the German language. The operators were given a course of training to familiarize them with the military phrases they might be expected to overhear, but fundamental knowledge of German was a necessity; time did not permit the teaching of the language, and a superficial knowledge was not sufficient. Most of the men selected were of German descent and accustomed to speaking the enemy language previous to entering the army.

Our first effort to obtain suitable men took the form of a request for the Signal Corps in the United States to send over all the German-speaking radio operators available. Inasmuch as the first detachment of 40 German-speaking radio operators, which arrived about the beginning of January, 1918, apparently exhausted the supply, it was decided to make no further efforts in this direction. It was found that the ability to receive and record T. P. S. (ground telegraph) messages was secondary to the necessity of knowing German thoroughly, as T. P. S. code was sent slowly, usually not exceeding the rate of 10 or 12 words a minute. All efforts were, therefore, directed to obtain personnel by selecting men already in the A. E. F. having a knowledge of German and teaching them the T. P. S. code.

Our efforts to obtain such men from the different line organizations in the A. E. F. were productive of many laughable results. Evidently the commanding officers of many units assumed that if a man spoke any foreign language it must be German, and with the numerous nationalities represented in our army the possibilities in selection are evident. Many also reported with only a smattering of German and were promptly returned to their outfits, except for a chosen few whose cooking ability was utilized in place of alleged philological accomplishments.

The selection of German-speaking soldiers also had its less humorous side. When the first detachment of operators arrived from the United States, the men themselves had no definite idea of their prospective duties. An intelligence officer was detailed to ascertain the extent of the linguistic ability of each member, and few made any effort, for they were fearful that signs of ability coupled with German names might be prejudicial to their interests. Only after it was explained that they were intended for a duty of a particularly valuable nature did they loosen up; even then some of them did not disclose their true fluency.

Special commendation is due the men in this service for their great devotion to their duties. Above all, a listening station operator had to be observing, possess imagination and be able to visualize the possibilities within snatches of enemy conversation that came to his ears, and he had to do it quickly if his intuition was to be of any value. We were fortunate in having in our service many men possessing all the qualifications, perhaps the best of whom were those who had been newspaper reporters before the war.

Proper conception of the operation of a listening station requires an understanding of the elementary electrical phenomena which it makes use of, principles which are the same as those used in the T. P. S. (ground telegraphy) operations. Figure 1 shows a T. P. S. buzzer transmitter with its ground connections at the end of wires of approximately 100 meters length. The transmitter is an induction coil taking about 5 amperes at 10 volts in the primary, and generating in the secondary coil a high voltage alternating current of audible frequency. The secondary coil is connected direct to the grounds, the lines of current flow between which are indicated by the dotted lines in figure 1. The equipotential lines (shown in full lines in the figure) are perpendicular to the lines of current flow. If two earth connections are made at points such as 4 and 6, which are not on the same equipotential line, and if the wires leading to the earth connections are connected to a pair of telephone receivers, a current will pass through the 'phones. If the current is of sufficient strength, the T. P. S. buzzer signals will be heard. If the current is weak—and it usually is—it is necessary to insert an amplifier in the wires leading to the earth connections. It was for this purpose that the vacuum tube amplifier came into use. The amplifier with the two wires and the earth connections—or "earthed antenna," as they are called—make up the essentials of a listening station. If, instead of the two earths 4 and 6, which are situated on two different equipotential lines, two earths, 5 and 6, on the same equipotential line are chosen, no current will flow and, therefore, the buzzer signals will not be heard by the listening station. For similar reasons two earths, such as 4 and 7, which are at a greater difference of potential than the earths 4 and 6, give stronger signals than the earths 4 and 6.

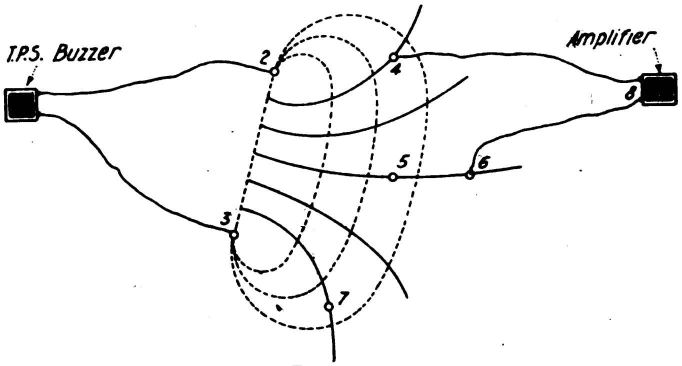


Figure 1

A T. P. S. buzzer transmitter with its ground connections at the end of wires of approximately 100 meters length

There is also another and lesser effect to be considered, the effect of induction. The circuit 1, 2, 3, is a closed circuit, the earth closing the circuit between 2 and 3. Similarly, 4, 6, 8, is a closed circuit. Therefore, the buzzer loop affects the amplifier loop to some extent by electromagnetic induction. Leaving out of consideration the question of phase difference, the inductive effect adds to the difference of potential effect, discussed in the preceding paragraph. In general, in a system such as shown in Figure 1, the inductive effect is much smaller than the difference of potential effect. Other effects such as the direct inductive and capacity reactions between the earthed antenna of the buzzer circuit and those of the amplifier circuit, etc., may be disregarded, because of their relatively small importance in comparison to the first two effects.

A grounded telephone system used as the source of signals may be considered in exactly the same way as has been done for the T. P. S. buzzer set; there is no difference between the two cases.

An insulated telephone system presents a slightly different case. This system influences the receiving station only by induction. This it does in two ways: first, by direct inductive action on the loop of the receiving station; and second, indirectly, by inducing earth currents which are then picked up by the earths of the receiving station. If the line wires of a well insulated metallic telephone circuit are twisted together, the resultant stray field is feeble, and hence any inductive effect is small. It is practically impossible to overhear signals on such a system.

If the two earthed antenna of the listening station (Figure 1) are entirely insulated from the ground, and if the ends, 4 and 6, are connected by a wire also insulated from the ground, we then have, instead of the earthed antenna, an insulated loop, and the station receives signals by induction only. The insulated loop system was used to some extent by the French.

Listening stations are a development of trench warfare and no activity of the Radio section was more thrilling and more interesting

A listening loop utilizes inductive principles only, and its main advantages over the grounded antenna—in which it is very similar to the radio loop—is its comparative freedom from ground static. Loops were not used extensively by us, because of the difficulties of properly maintaining and repairing them. Loops installed in trenches are too liable to injury, so we placed our reliance in grounded antenna. Several turns in the loop are necessary to obtain satisfactory results and this naturally adds to the maintenance difficulties.

It must be remembered that these listening stations can be used only where conditions are favorable and when the opposing armies are fairly close together, as in trench warfare; and also when the intervening conditions of the terrain are such as will not shunt or side-track the currents which it is desired to intercept. An intervening river or gully or metallic geological formation was found to prevent successful operation in many places.

It was necessary to get the ground plates as close to the enemy as possible, and their installation required the highest type of bravery in the men who accomplished it. The personnel operating listening stations were continuously on duty one week, then off one week, which kept them in the front lines considerably longer than was required of the infantry under ordinary conditions.

The dugouts in which the stations were located were usually a few hundred meters from the front line, and generally in the support or communication trenches; but some times they were concealed under the ruins of a demolished house or structure. One of the first stations established in the Toul Sector, where most of our troops of all services obtained their first taste of real war, was in the village of Marvoisin at the foot of the ever menacing Mt. Sec. The dugout was located under the ruins of an old stone church which had been demolished by shell fire, but it was seen that these ruins formed a fine protection for the station when an enemy shell made a direct hit, but did not penetrate into the dugout proper. The force of the concussion demolished the amplifier and threw the operator on duty off his comfortable seat; it also greatly enhanced his respect for churches.

From the dugouts the leads followed the trenches to their terminating grounds, located at intervals of several hundred meters along the front line trenches and close to the enemy lines as possible. These grounds consisted of copper mesh mats about two by ten feet, buried a few feet under ground. If it was impractical to thus install them, a group of metal stakes were driven down.

Because of the large area covered by the ground antenna these stations were more effective in receiving T. P. S. messages than the regular T. P. S. receiving stations in which grounds were usually separated by approximately 100 meters. Nearby radio stations could also be heard when the French amplifier was used, a combination apparatus providing for the rectification and amplification of radio signals in one position of its control switch, and low frequency amplifications with all three tubes, with the other position. Even when so used, it was found that radio signals could be heard in it. Investigation developed that the first low frequency transformer connected to the ground antenna showed a capacity reactance to radio frequency currents due to its distributed capacity. The inductive effects of this radio frequency current on the remainder of the amplifier wiring evidently resulted in the unintentional detection of radio stations and a demonstration of grounded radio antenna possibilities.

Because it was possible for the listening station to select different grounds, an idea of the approximate direction and distance of a transmitting station might be obtained by an operator of long experience. T. P. S. messages could be heard for as much as 4 kilometers and telephone conversations 2 kilometers. This distance of course depended on the degree of grounding of the telephone lines. The listening station shown in the accompanying photograph does not by any means represent a typical one. It will be observed that it has been located in the same place for a considerable period. This station was located in a Vosges mountain sector on the extreme right of our Toul Sector and was operated jointly by the French and ourselves. The quietness of this sector is attested by the neatness and the apparent comparative comfort.

From the station dugouts the insulated leads radiated to the grounds, which were from 500 to 1500 meters away, and distributed along the front line trenches at intervals of from 200 to 300 meters. They were often carried well over toward the enemies' trenches, for the effectiveness of the station was dependent on the distance to the source of the intercepted current, as will be appreciated from the foregoing explanation. Grounds were also installed in our own area back of the station for use when it was used as a monitor for our lines. Because of the proximity of listening stations in this work it was much easier to overhear the communication within our lines, and by the same token this drowned out much of the German communication we were trying to copy. Listening stations have more interference to contend with than a radio station, because the element of tuning is not available and because of so-called "earth static."

The principles used in listening stations are well known and have long been utilized, but only with the development of the super-sensitive vacuum tube amplifier did their possibilities become valuable for war purposes. The type 3 ter French amplifier first utilized has already been described. Later the type SCR-72 amplifier was received from the United States, and was found to be a trifle more efficient for voice and audible frequency currents. The circuit for this amplifier is the usual audio frequency amplifier utilizing two tubes as against three in the French amplifier, but it was only intended for low frequency amplification and no provision was made for rectifying radio frequency currents as in the French instrument.

Many times it seemed that the Germans were providing an electrical screen for their communication, for their motor noises came in so loud in some cases that we believed they had intentionally carried over wires from their machine and grounded them near or in our lines so as to drown out the signals from their T. P. S. stations further back. However, it was noticed that if these motor noises stopped there was an immediate increase in the T. P. S. activities so that if it was a purposely provided screen it would have also been effective in interfering with their own ground telegraphy. No doubt it was effective in protecting their defective telephone lines.

That the operators determined the efficiency of our listening service, however, is a fact that must not be lost sight of. This service could not be organized as scientifically as the radio intercept stations, in which gonio stations could locate the radio stations intercepted and wave lengths could be measured and other characteristics of the stations recorded. The listening station operator had only his ear to aid him in determining the probable distance and location of the station he overheard. T. P. S., like radio, has characteristic notes and the operator's "fist" also betrays itself, but neither of these are as pronounced as in wireless.

The listener had therefore to depend on his judgment to determine what any unusual occurrence or activity might foretell, in addition to what might be revealed by the decoding of the message he recorded. He soon learned that unusual T. P. S. activities by the enemy forecasted a military offensive or some unusual operation. For weeks his efforts might be unproductive, but his vigilance could not be relaxed. A probable change in an enemy station could be noted by a change in its note or in its intensity. A sudden change in the T. P. S. communications indicated a difference in the troops opposite or a rearrangement of their lines. The first information regarding the relief of enemy battalions opposite was usually obtained through our listening station operators noting the change in their T. P. S.; in nearly every case the operator's deduction would be later verified by a prisoner.

By diagramming the T. P. S. stations of the enemy according to loudness and the stations with which they worked, operators could quite accurately place the large and small units, their observation posts and posts of command. Just previous to the St. Mihiel operations, the operators quite accurately reported the withdrawal to the rear of the enemy T. P. S., which indicated the removal of troops from the front lines, or at least a rearrangement of the forces.

The listeners were repeatedly commended by the General Staff for their intelligent deductions, especially with regard to telephone interceptions. In this work—which could not be recorded literally—the operator had to act as an intelligence officer. One man deduced the arrival of a new division opposite him by the increased politeness used in telephone communication, and he proved to be right in his surmise. As the Germans also used code words for all places and military phrases in their telephone conversation, only the slightest clues were available for making deductions. Through hearing a certain time spoken repeatedly by the enemy and its anxious reception at the other end of the lines, the 42nd Division was warned of attacks on Ferme-le-Chamois, Village Negre and La Chapellette, and being forewarned they effectively repulsed the offensive.

The most hazardous part of the operation of the listening station was in the maintenance and installation of the ground lines. The entire effectiveness of the station obviously depended on the maintenance of the lines in good condition; they were continually broken by artillery fire and the necessity for repairs was always immediate.

It was at these lines that the fibre of the station personnel showed at its best. Usually wearing their gas masks, the men stuck to the task, in most cases under shell fire, until they had established their circuits. In one instance all three operators of the station were wounded during an attack on our position. The majority of casualties in the Radio Section occurred in this service, and there is not one case of a man shirking his duty. If a station was not getting satisfactory results it was usually the operators who suggested the advisability of carrying the grounds over nearer the German lines, then they would volunteer to install it themselves.

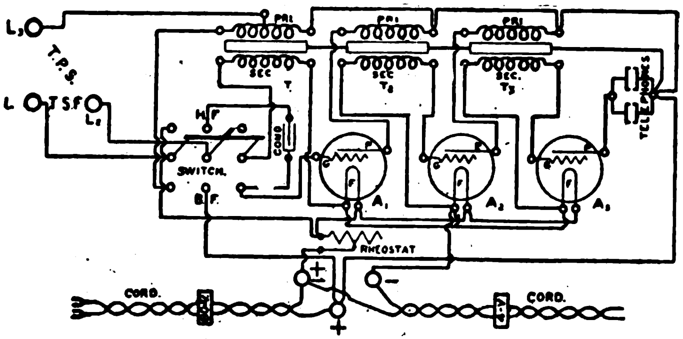
DER FEIND
HÖRT MIT!
VORSICHT
AM FERNSPRECHER!

Facsimile of German poster distributed amongst the German Intelligence Service for the purpose of retaining secrecy

These night excursions to bury ground mats in the enemy area showed our men's intense interest and devotion to their work. At these times they were usually accompanied by a covering patrol and it took many hours of slow arduous crawling through barbed wire entanglements and across No Man's Land to carry the wire to the desired location. Then followed the stealthy burying of the mat to accomplish the desired end. Star shells threatened to reveal their presence every few minutes and they could advance only during the intervening periods. Returning, they might be taken for an enemy raiding party by some nervous doughboy and be received accordingly. This actually occurred more than once.

The Seicheprey fight was waged all around one of the listening stations and for a time it was behind the German front. Fortunately, in the night and the confusion its existence was not realized by them and when American counter-attack recovered the ground the operators were still on the job.

Another factor that increased the effectiveness of listening stations was the possibility of connecting on to old and grounded lines running over into enemy territory. In the continual surging back and forth of their fronts both armies necessarily abandoned lines in areas which later came under enemy control. The trenches were a mass of old and abandoned wires of both sides and these were usually the bane of the telephone men of our Signal Corps in taking over sectors from the French. Their greatest ambition seemed to be to tear them all out and start over with new and better circuits, thus in many cases they destroyed a source of information for us. In one case the allied armies were notified of a commercial underground cable, installed before the war, but lying behind both lines; this cable possibly would have been a fertile source of information to the army that could connect to it without the other's knowledge. Some of these old circuits that extended far back into our lines were certainly the source of information to the enemy, as there were reported many incidents, such as the shelling of expected relief troops or truck trains in the night, which could only have been ascertained by intercepting telephone conversations, possibly only a few minutes before the expected arrival. A typical instance was that of a Brigade headquarters which received its supply trucks every night at a regular hour, and as regularly the road was shelled. It was assumed the Germans had in some manner ascertained this hour and it was decided to change it. Arrangements were made over the line and, sure enough, the time of shelling changed also. Inasmuch as the headquarters was too far back for an ordinary listening station to be effective, it is probable that the Germans had connected to an old line running back over the intervening five or six kilometers.



Circuit diagram of 3-ter amplifier

One of the most daring feats in the listening service was that performed by Private 1st Class George Stroh, who volunteered to accompany a raid on the German position at Marcheville, and install a ground connection for his station inside the enemy line. He went along with the attacking party carrying his wire ground stakes and tools, and when the infantry had attained its objective he coolly proceeded to hammer in his stakes and lay his wire as he returned to his listening station in Soule.

Sergeant Carleton R. McQuown, while installing a ground at night near the enemy lines, discovered a machine gun nest, and the following night an American raiding party acting on his information succeeded in destroying it and capturing twenty-eight prisoners.

Incidents like these, indicating the bravery and resourcefulness of the listening station operators, were so numerous that only a few can be mentioned. It has repeatedly been said that the glamor has gone from war, but the experiences of these men, who in the new warfare combine somewhat the duties of both the scout and the spy give this assumption the lie. Among the men cited for their work by the General Staff were Corporal (later Lieutenant) Frank B. Fairbanks, Sergeant Braun, Corporals Floyd F. Felmick, L. V. Garner and H. T. Schoefer, and Privates 1st Class L. V. Pease, D. O. Butterfield, W. R. Hogel and Geo. J. Baum.

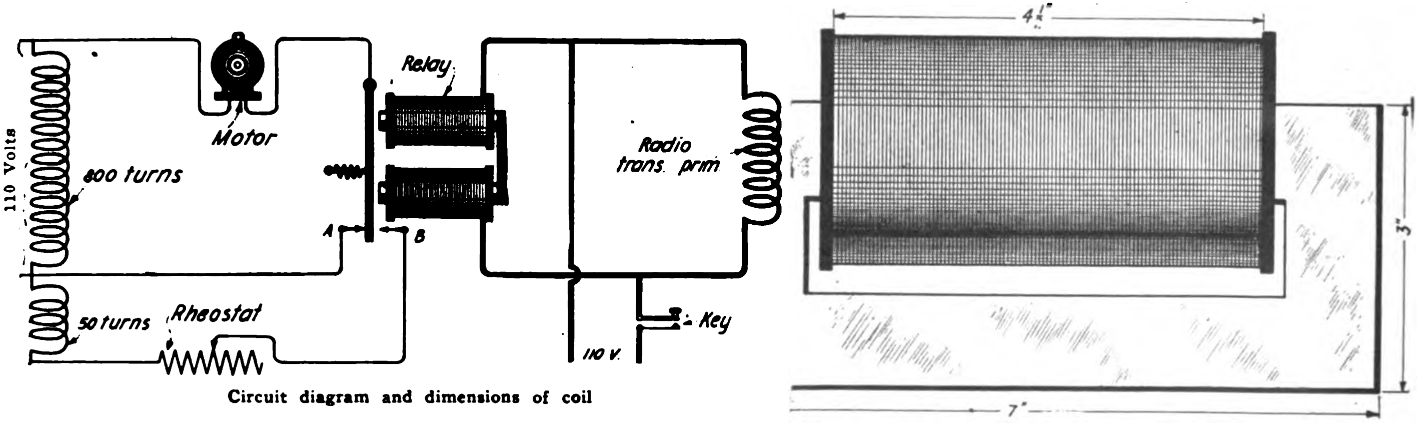
If anyone could be expected to be "fed up" on war, listening station operators certainly qualified. These men, in many cases for nearly half their term of service in France, had for their quarters dugouts the size of a packing case, with smelly pools rising in the bottom and rats and smaller but no less active intruders as constant companions. Under these conditions they worked, ate and slept—certainly they can claim to have done their bit for their country.

Constant-Speed Regulator for Series Motors

By L. A. Bartholomew

In many amateur stations where a series motor is used for the rotary spark gap, in connection with a transformer of considerable input, the voltage drop when the key is depressed is sufficient to slow down the motor somewhat resulting in a disagreeable "whine" in the spark note. Sometimes this can be remedied by increasing the size of the wiring in the station, but more often it is due to insufficient capacity of the power company's feeders which is beyond the control of the consumer.

A method which has been found to give excellent results in such a case, and which may be of value to other amateurs troubled in the same way, is to insert a small auto-transformer in the motor leads with a double contact relay connected to the key. Figure 1 shows the circuit for such a device. When the key is open, the regular line voltage flows into the motor through the contacts A. As soon as the key is pressed, however, current also flows through the relay magnets, actuating armature and closing contacts B, which connects the motor across the entire winding of the auto-transformer, and the increase in voltage will compensate for the drop due to the



Circuit diagram and dimensions of coil

(Continued on page 22)

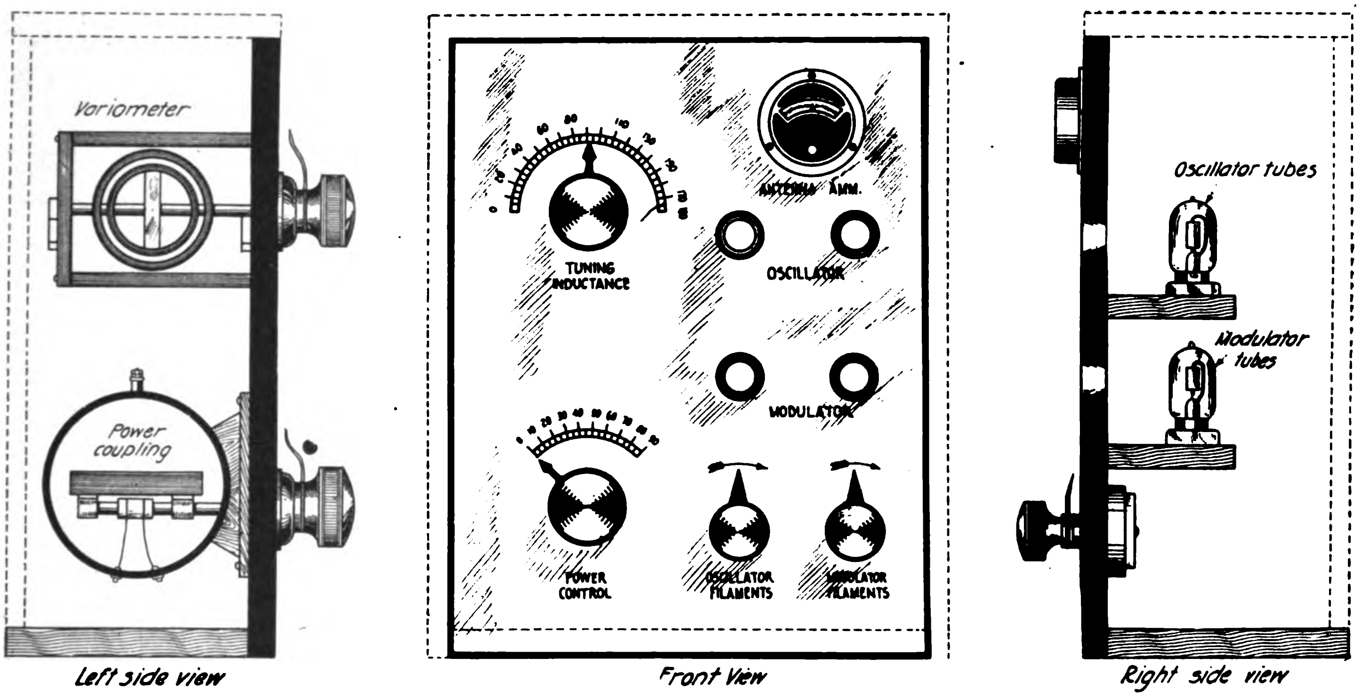
25-Mile Radiophone Transmitter Using Marconi V.T.'s for 200-Meter Amateur Work

By Chas. R. Leutz

A GREAT many amateurs would undoubtedly like to construct a short range 200-meter radiophone transmitter, using the Marconi V.T. tubes that are available, so I am undertaking to describe in detail the plans of a set which has shown its ability to work twenty-five miles in the day time with normal conditions prevailing.

Only four V.T.'s were required for the transmitter. The antennae used at both transmitting and receiving ends consisted of four wires, spaced three feet, each 100 feet long, T-type, with an effective height of 100 feet. Capacity was approximately .0008 microfarad and the fundamental wave length about 125 to 150 meters.

A Paragon short wave regenerative receiver was used at the receiving end with marked success. Two steps of transformer coupled amplification (audio frequency) were tried, and from the resulting increase in signal audibility, it is estimated that a range of 50 miles could be covered under favorable conditions.



Left side view — Front View — Right side view

Figure 10—Panel assembly of the various instruments

Any V.T. acting as an amplifier or "repeater" will generate oscillations if coupling is provided to transfer energy from the output circuit back to the input circuit. The period of the oscillations may reach either audio or radio frequencies, which will depend upon the natural periods of the wing and grid circuits. For practical purposes and for adjustment to any desired wave length, only one circuit should control; as the wing circuit contains the most energy, it is the most suitable controller.

A schematic diagram showing the wiring of the circuit used is given in figure 1. It may be stated in this connection that the circuit used is not the most reliable and steadiest known, but this oscillating circuit does give a much better output with a given number of tubes than with more stable circuits where output has to be sacrificed to gain reliability. However, with intelligent operation, perfectly satisfactory results can be obtained.

The construction of the individual component parts of the complete transmitter will first be taken up separately and, as a suggestion, a drawing of the complete transmitter shown.

Figure 2 gives a cross-sectional view and an end view of the microphone transformer. As the schematic diagram indicates, a telephone microphone, a four-volt dry battery and the primary of the microphone transformer are in series. Speech directed into the microphone results in electromagnetic transformations in the transformer in accordance with the pitch and volume of the speech, and, subsequently, potentials are developed across the secondary of the microphone transformer, these potentials varying in accordance with the pitch and volume of the speech. This potential is thrown on the grids of the modulating V.T. tubes and modulates the oscillating current in accordance with the speech directed into the telephone microphone. Any ordinary telephone transmitter may be used, but a little experimenting will prove that some are far superior to others.

The construction is clearly shown in the drawing. The core consists of a bundle of soft Norway iron wire, No. 22 B&S gauge, ¼" diameter, 4" long. Two end pieces of dilecto 1½" square and ¼" thick are placed on each end of the core. Two layers of .010" Manila paper are shellacked to the core for insulation and it is then ready for winding. The primary winding consists of 230 turns of

No. 26 B&S double cotton covered wire, one layer of .010" paper between layers of wire. Over the primary winding, two layers of .010" Manila paper are wound and shellacked for primary-secondary insulation. The secondary winding can then be placed on, consisting of 6,520 turns of No. 36 B&S enameled copper wire. A piece of Empire paper .001" should be placed between layers of the secondary winding. The start and finish of the windings should preferably be heavy flexible wire, such as lamp cord, which will allow external connections to be made safely.

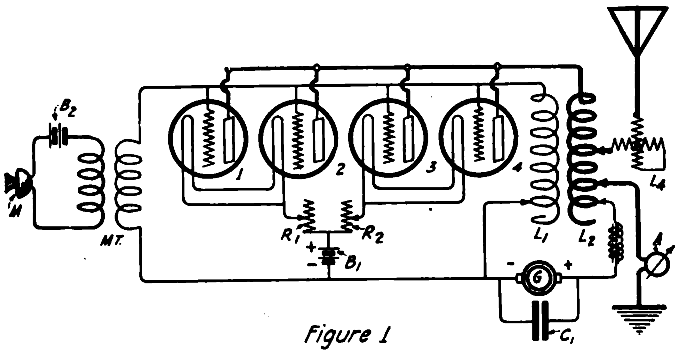


Figure 1—Schematic wiring diagram of the circuit used

Figure 3 shows, cross-sectionally, the constructional details of the audio frequency choke, shown in the schematic wiring diagram. This coil is placed in one leg of the generator line lead to prevent radio frequency oscillations from passing into the generator, or direct current supply.

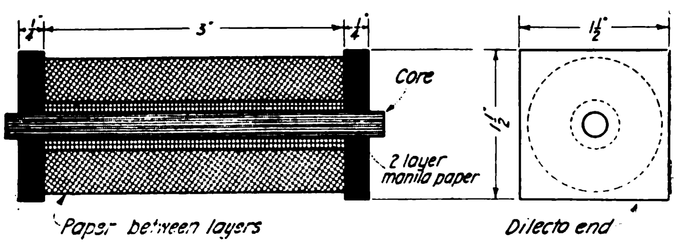


Figure 2—Cross-section and end view of the microphone transformer

The constructional details are very simple. Seventy leaves of .014 silicon steel, 6" long by 1" wide, are packed together and taped evenly with friction tape, making a core one inch square. Five layers of .010" manila paper are then shellacked on and the form is ready for winding. A total of 3,600 turns of No. 36 B&S copper enameled wire are wound on in layers, one layer of .001" Empire paper being wound between layers of wire. The winding space should only occupy 5" so that there will be space left on the core to place end pieces for support of the core by clamps, when assembling into the complete set. The start and finish of the winding should be a 6" piece of lamp cord, so as to provide substantial external connections. For the sake of appearance all coils may be covered with one layer of pebbled book binders' cloth.

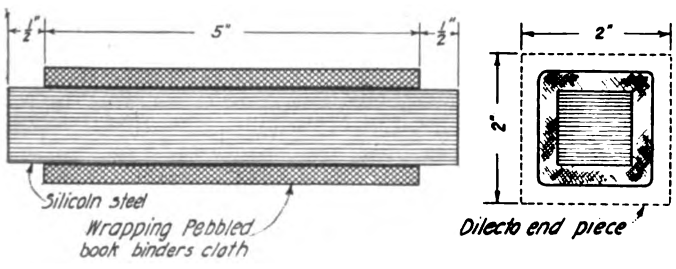


Figure 3—Constructional details of the audio frequency choke

Referring to figure 4, the method of mounting the Marconi V.T. tubes is shown clearly. The upper shelf holds the two oscillating tubes and the lower shelf holds the two modulating tubes. The tubes are mounted vertically, so that the filaments will not sag when they are heated and thus touch the grid. Observation holes may be cut into the windows so that the brilliancy of the filaments may be noted.

Figure 5 gives the assembly sketch of the filament rheostats, two of which are required. One controls the two oscillating tubes, and the other controls the two modulating tubes. A strip of fish paper, or other flexible heat resisting insulation, ½" wide by .040" thick, and 3" long, is wound with No. 24 Advance resistance wire, 26 turns to the inch. The last few turns at each end are soldered together to prevent the winding from getting loose. After this strip is wound, it is forced into the circular slot in the dilecto base, as shown in the drawing. An adjustable contact with suitable bearings is shown so that the resistance may be varied in accordance with the value desired.

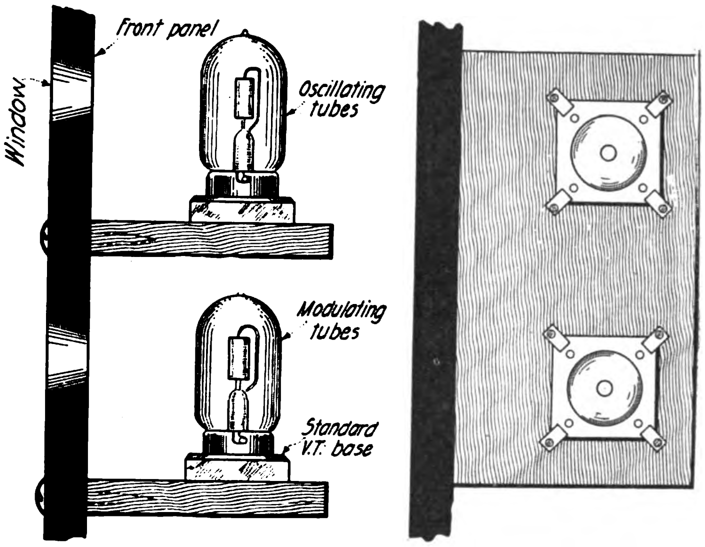


Figure 4—Method of mounting the Marconi V. T.'s

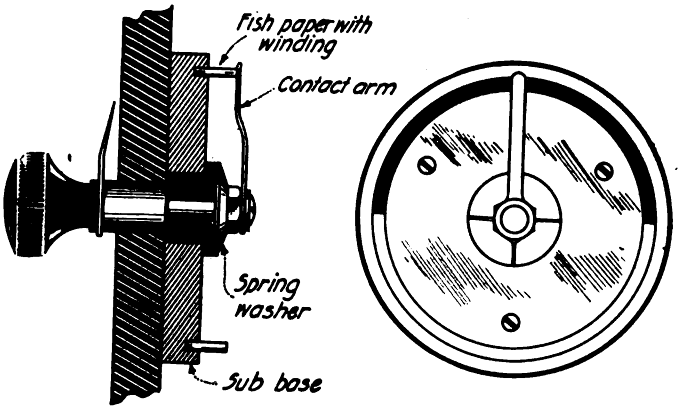


Figure 5—Assembly of the filament rheostats

In the circuit diagram, it will be noted that a condenser is shown in shunt to the high potential generator. This should have a minimum capacity of 0.10 microfarad and should have enough dielectric strength to stand the full generator potential continuously.

A suitable 400-volt direct current generator may now be purchased on the market, or a lower voltage generator rewound and driven at a higher speed to give the necessary 400 volts. The generator should be one able to deliver about 125 milliamperes.

A description of the most important parts of the transmitter, the inductive coupler and the antenna tuning variometer, follows: For best efficiency the coils should have low distributed capacity and subsequently low high frequency resistance. For 200 meter transmission, investigations prove that solid wire will have the same or lower high frequency resistance than coils wound with Litzendraht, sometimes called high frequency cable. However, if longer wave lengths are to be used, say about 400 meters, high frequency cable may be used to advantage.

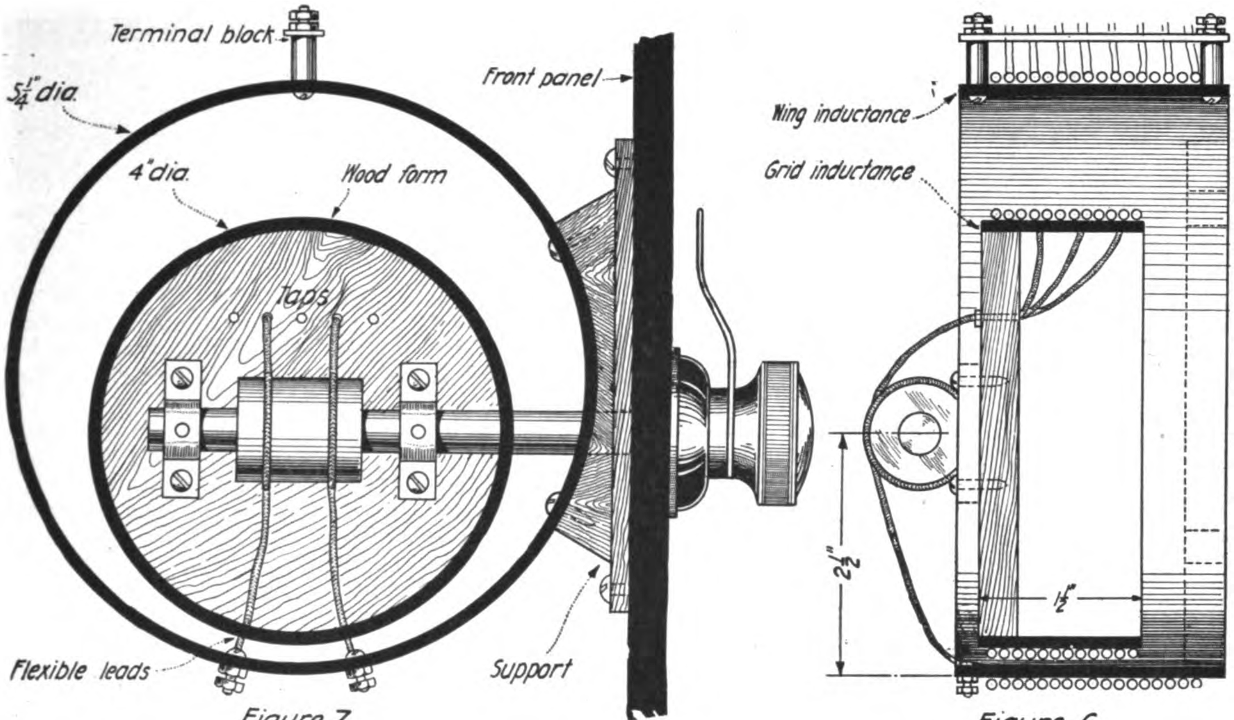


Figure 7 Figure 6

Figure 6—Front sectional view and Figure 7, side view of the construction of the coupling device

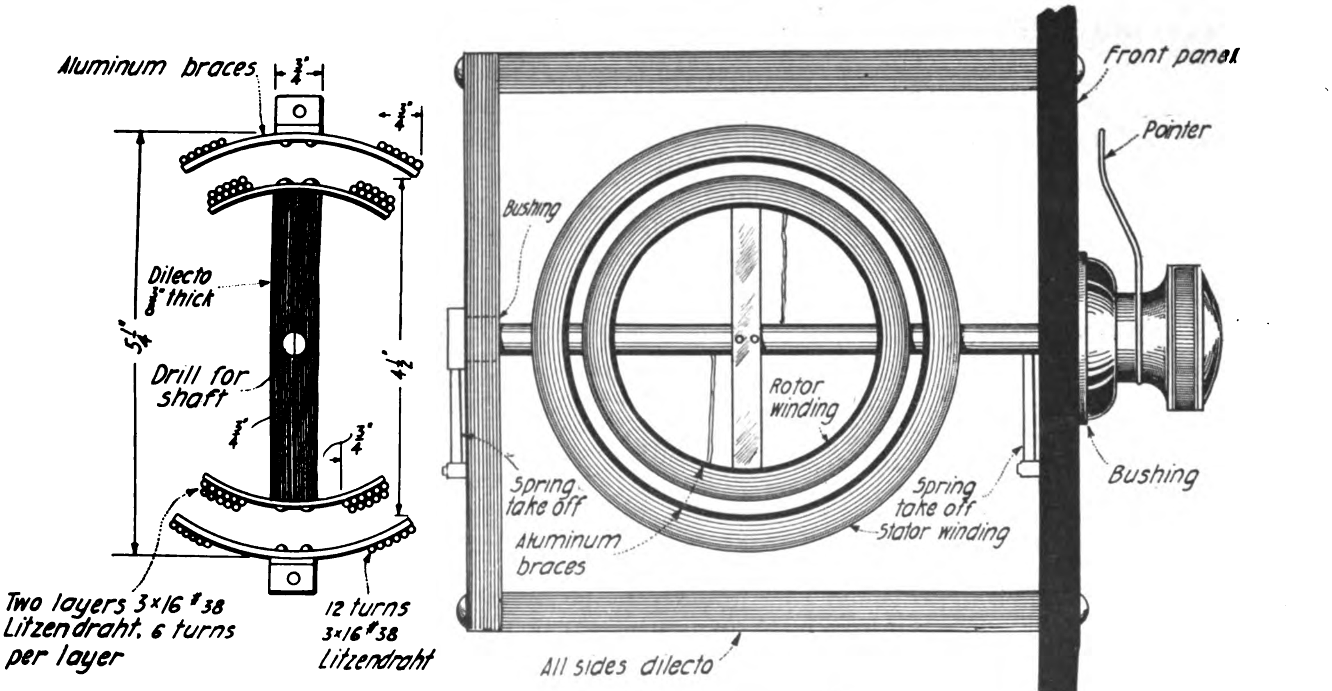


Figure 8 Figure 9

End and side views of the antenna tuning variometer

The wing inductance is wound on the stationary tube, figure 7, which is cardboard or dilecto, thickness ⅛", outside diameter 5½", and 2½" long. Upon this tube, 40 turns of 3/16 No. 38 Litzendraht, or No. 22 D.C.C. copper wire are wound. Taps are taken every three turns and brought up through the terminal block shown, so that substantial external connections may be soldered to the taps. Litzendraht may be successfully tinned by first dipping the wire in soldering acid and then heating to a cherry red, then wiping with cotton waste. Bare copper should then be dipped in a half-and-half solution of alcohol and rosin and dipped into a tin bath. After winding, all coils should be given a coat of Sterling or Ajax varnish and left to dry in an oven at about 200° F.

The grid or movable inductance is wound on a tube 4" outside diameter, ⅛" thick and 1½" long. This is wound with thirty turns of the same size wire as on the stationary coil. Taps are taken out every three turns and brought to brass studs, so that the two flexible leads may be connected to any of the taps as required in operation.

The constructional details of this coupling device are clearly shown in figures 6 and 7.

The antenna tuning variometer is shown in figure 8 and figure 9. Sufficient dimensions are given to allow the constructor to make wooden winding forms to wind the stator and rotor coils. The same form will do for both halves of the stator coil, and then the form may be turned down to wind the rotor coils on. Either 3-16-38 Litzendraht or No. 20 D.C.C. copper wire may be used, preferably the latter, as the coil will hold its shape better. After winding, the coils should be dipped in hard beeswax and left to dry before taking from the form.

Small aluminum brackets are made to hold the coils in their proper places and to the frames. The two rotor coils are connected together so as to produce a continuous winding in the same direction. Leads are brought to the shaft, which is split and insulated in the center. Flexible springs from which connections are taken are soldered on the shaft ends. The stator coils are also wound so that the coil is in one continuous direction. These two coils are in series and maximum inductance is obtained when the two coils add in the same direction and minimum inductance when they oppose.

Figure 10 shows a possible assembly arrangement, but this may be altered to suit the individual taste. Connections should be made with heavy wire and all joints soldered, using the alcohol and rosin flux.

The operation of the transmitter is very simple. Starting with tight coupling on the power control, connect the high potential direct current and heat the filament to normal temperature. Oscillations will be indicated by radiation, noted from the aerial ammeter. The four taps of the wing inductance and the two taps of the grid inductance will now have to be adjusted until maximum radiation is obtained, consistent with the wave length desired, final tuning being accomplished with the antenna tuning variometer. Definite connections cannot be stated for the taps as the inductance of the connecting leads of the various sets built will vary too widely, but the right selection of taps is not difficult.

The microphone battery circuit is closed after maximum radiation is obtained and the set is then ready for transmission. Good modulation will be indicated by a slight decrease in antenna current while speaking into the microphone.

The Coil Aerial

Its Use as a Direction Finder

By Leon T. Wilson

DESPITE some limitations, the coil aerial has jumped into a position of considerable importance in the last few years, and a large amount of research work has been expended in an effort to find out just what is its peculiar field. For the benefit of those who desire to take up this very interesting field of experimentation and research a description of the construction and use of the aerial as a direction finder will be sketched. There is still a great deal to be done in investigating this peculiar type of aerial, and the opportunities for the amateur to be of real constructive assistance to the art are manifold.

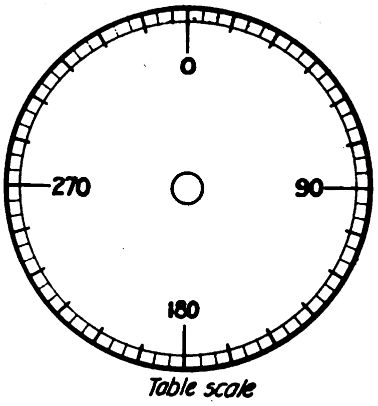
LIMITATIONS: There are only two disadvantages of the coil aerial which demand serious consideration.

FIRST: It is not suitable for long wave work, either in transmission or reception unless unusual facilities are available for the erection of a very large coil. In commercial work, of course, this limitation is almost fatal, as it bars the coil aerial from use on wave lengths over 300 meters. For the amateur this does not mean much, as he is restricted to transmit on wave lengths of 200 meters or less.

SECOND: The general bulkiness and unhandiness of this type of construction, especially in the larger sizes, makes it difficult to construct a rigid and durable frame with the facilities at hand for the average amateur. Do not think that this is an objection of any moment in making a direction finder, though, for as we shall see in the details of construction, the square coil is only about 4 feet on a side. Such a small dimension as this is perfectly easy to handle and pivot. It is only when the coil grows to 20 or 30 feet on a side, as it must be to compete with the results of a flat top antenna, 40 or 50 feet high, that we get into difficulties.

ADVANTAGES—FIRST: A coil aerial, can, in general, be made to have less resistance than an average flat top antenna. The tuning is therefore sharper, with resulting clarity and ease of reception, due to the decrease of interference.

SECOND: Besides the effect of lessened resistance on interference, there is the unmistakable effect of the directional qualities of the loop on clearness of reception. This is due to the fact that when the coil aerial is set for the best reception of any particular station, all other stations, with the exception of possibly one or two, come in at an angle to the coil, and their strength is consequently decreased. The intensity of signals decreases the nearer the line of direction is to a right angle with the plane of the coil.



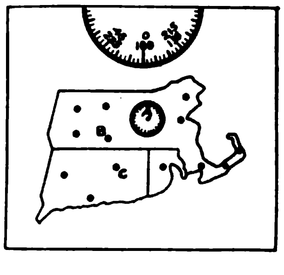


Figure 2—Compass card. Figure 3—Plotting board

THIRD: The coil aerial generally gives a smaller stray to signal ratio. That is, the intensity of the "static" coming in is smaller in comparison with the intensity of the signals, than is the case of a flat top antenna.

FOURTH: A coil aerial has the peculiar properties of being able to indicate the *line of direction* of any transmitting station. Basically, this is due to the fact that any solenoid made up of a few turns of wire on a frame that is considerably larger in the dimensions of its cross section than it is in length, gives a minimum signal when its plane is at right angles to the line of the incoming wave. An approaching wave front strikes both sides of the coil at the same time, if the coil is facing the wave, and the currents set up in opposite sides of the coil neutralize each other. If the coil is swung into any other position the wave front does not impinge on the two sides of the coil simultaneously, and consequently some part of the current is left unbalanced. This unbalanced portion produces the signal. This effect is the same from whichever side the wave comes, hence the coil will indicate the *line of direction* only.

Since the line of direction only is given, it is necessary to have at least two stations take and compare observations, if actual locations are to be determined. The point of intersection of the lines of direction is the location of the transmitting station. In general, a well constructed aerial will give directions accurate to two degrees. Best results can be obtained with reports from more than two stations, as the additional reports serve as a check on the others. The use of the minimum signal point gives much sharper definition of direction than the maximum. It is evident that the nearer the reporting stations are to 90 degrees with each other, the more accurate can the intersections be plotted.

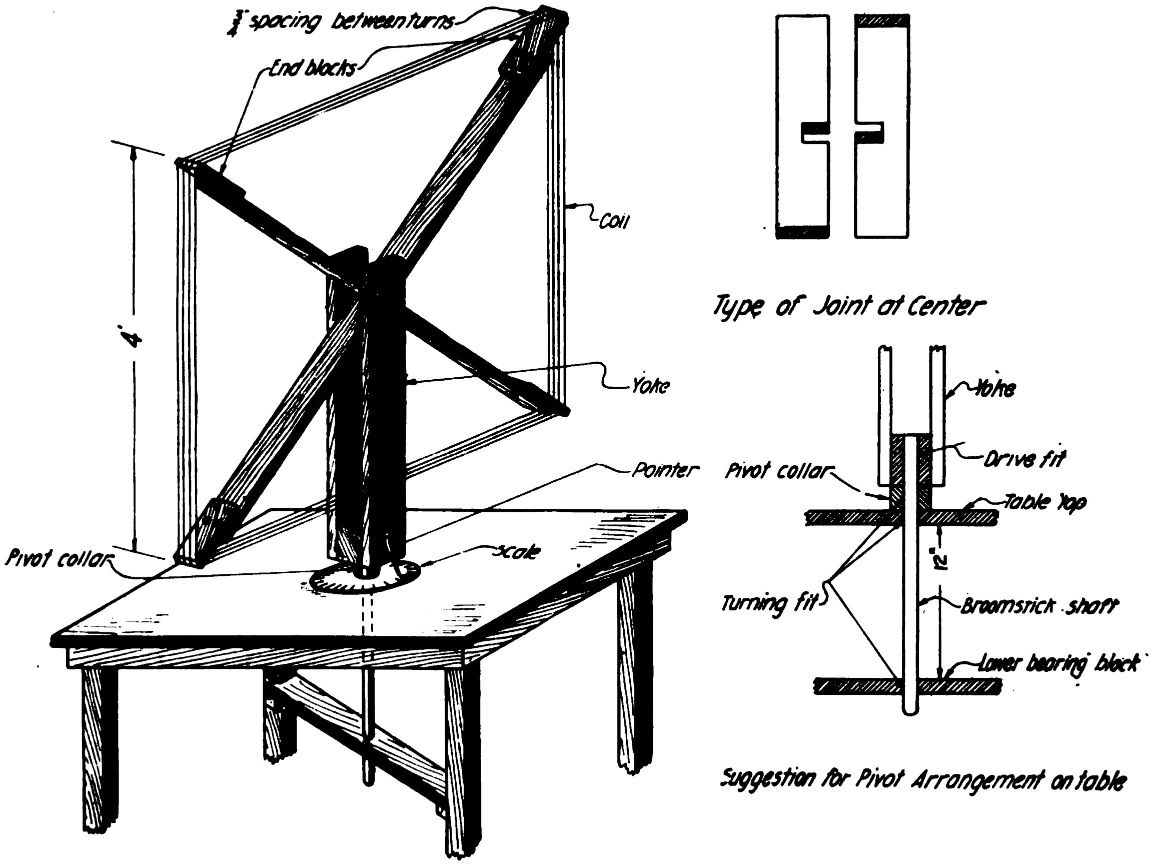


Figure 1—Detailed constructional view of the coil aerial

Construction Suggestion—A size convenient for indoor operation, on 200 meters, is a square loop, 4 feet on a side. The frame may be made up of cheap wood, varnished or shellacked. Four turns of No. 18 D.C.C. copper wire will be sufficient. Space the wires ¾" apart in the form of a helix. This means that they must be laid on the edge of the frame. For experimental work with the aerial, the frame shown in figure 1 is easily constructed, and has the advantage of the corner blocks being easily removable for a change in spacing or number of turns used. Leads may be tapped out where convenient.

Mount the frame in a yoke, and arrange the yoke on a tripod or a table, so that it may be rotated about a vertical axis. Make a pointer to fix to the yoke, so that it will rotate with the coil and indicate the direction in which the axis of the coil is pointing with reference to the scale. To the tripod or table attach a compass card, or circle divided into 360°. This card should be at lease 6" in radius, 12" in diameter, with every five or ten degree mark distinctively drawn and numbered, as in figure 2.

Place the scale so that the zero point is to the north, as determined with a pocket compass. This is one point that must not be overlooked, as otherwise two or more observers will have no common zero from which to report their lines of direction. Be sure, then, that the scale reads zero when the face of the coil is due north. For permanency make the card of a thin piece of wood, or mount the drawing on a heavy back of similar nature. If a table is used, simply fasten it to the table top.

When the amateur is satisfied with his execution of these details the coil may be connected into circuit, and the desk instruments tuned.

Plotting Board—To use the coil aerial as a direction finder we must have a map and a simple form of an alidade, for plotting reports.

Secure a cheap drawing board, or mount a map of the territory you wish to cover on a table top. If a drawing board is used, paste it on with the edges of the map and board parallel. Now, using compass and protractor, lay off a semicircle of 6" radius and divide it into degrees, having the center of the semicircle at the center of the top edge of the board, see figure 3. Number every 5-degree mark so that it reads for both ends of the diameter of which it is one end. The drawing makes that clear. About the location of your home-station circumscribe a complete circle of 2" radius and divide that into degrees, every 5th degree as before, only numbered consecutively. Zero is always to the north, or top of the map.

To each of a half a dozen or more push pins attach a heavy thread with a small weight at the end. These are to insert at the locations of the home station and other reporting stations. The threads indicate the lines of direction, and their intersection point locates the unknown sending station.

The alidade is an instrument by which the angle of direction can be laid off from any point on the map. It consists of a cheap T-square, or if one is not handy, of two pieces of thin wood joined together as shown in figure 4. The blade is about 30" long—or 6" longer than the width of your map board, of 1/8" x 2½" stock. The head is about 8" long, of 3/8" x 2½" stock. They are joined with a screw and thumb nut, so that the blade may be turned to make any desired angle with the head. If a T-square is purchased, remove the small screws which hold the blade solidly to the head, and substitute the screw and thumb nut mentioned.

This completes the construction of the accessories for direction finding.

To locate the direction of a station, ascertain the direction from the home station by reading the angle of the incoming wave on the scale of the coil. Transfer this angle to the map by inserting one push pin at the home station and laying out the thread over one of the two possible angles. That is, a station may be either 90°, or 270°—as you only know the line of direction. In most cases you can guess correctly which one, but positive check will come with the report from the station co-operating in finding the direction. When his report comes in turn the blade of the alidade to the proper angle on the large semicircular scale. Then slide the head of the alidade along until the blade edge crosses the location of the reporting station. The intersection of this line with the line from the home station locates the transmitting station. If reports from other stations are to be obtained, insert a push pin at each station, laying out the line of direction with the thread as in the first instance. The more reports you have, the more accurately can you allocate the sending station, a result most desirable when attempting to spot a station that is jamming the ether with an obnoxious variety of wave lengths.

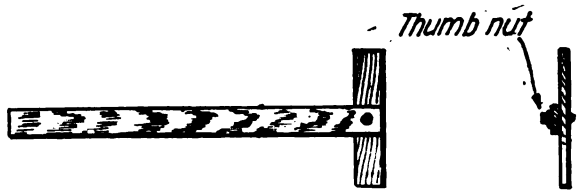


Figure 4--Method of constructing the alidade

Some Precautions—In operating such a coil aerial as a direction finder some precautions are necessary. In order that a sharp setting may be obtained the grounding of any part of the receiving apparatus should be avoided.

If operated indoors the coil should be at least the length of one side of the coil away from the sides of the room to avoid undue absorption in the walls. Likewise the coil should be well away from masses of metal such as steam radiators, pipes and the like.

If operated out-of-doors, unshielded, the coil *and receiving apparatus* should be several feet off the ground, preferably as much as 7 feet.

If it is desired to operate the set closer to the ground a grounded horizontal shield placed above the loop may be used to advantage. This shield may be built of parallel wires arranged in a harp-like fashion. The wires should be long enough to extend about 6" beyond each end and wide enough to extend 6" beyond each side of the loop. A ¾" spacing of these wires will do nicely. The shield should have its wires parallel to the top wires of the coil. They should be joined at their centers and grounded. In general such a shield will sharpen the minimum setting considerably and will also serve to decrease the ratio of strays to signals.

If the signal received on a coil aerial is weak, the minimum setting of the loop may be very broad. That is, there may be a zero signal over several degrees. In such event, the direction of the sending station may be approximated by taking the mid-point of the section of the scale over which a minimum signal occurs.

Although the direction of the incoming signal is of course perpendicular to the plane of the coil when it is set on a minimum, this is not always the true direction of the sending station, especially if the wave has passed over land for a considerable distance. This is because the waves do not necessarily radiate in straight lines. They tend to follow good ground paths such as are offered by rivers. Where a wave passes entirely over water the propagation is practically a straight line. A number of reports will get around this difficulty in most cases.

In this article only the simplest form of construction has been outlined. As in everything else pertaining to radio work, care and accuracy in detailing the various parts are sure to bring their reward in increased and more dependable results. Research and experimentation in this field will be not only fruitful but interesting, and the amateur is urged to investigate the possibilities of the device to the limit of his abilities.

Uni-Control Receiver Without a Coupled-Tuned Circuit

N an invention of Roy E. Thompson, he claims to have discovered that, in the use of two circuits in a radio receiving set, closely coupled together, a transfer of energy from the first to the second and its utilization in useful work in the second can be effected equally well at any period of the first circuit and wholly independent of the period of the second circuit, provided the second circuit be properly constructed.

Heretofore at radio receiving stations it has been customary to employ two circuits supplying the detector and telephone, these two circuits being termed the antenna circuit and the secondary circuit, and heretofore the most efficient use of the received energy has been obtained when both circuits were made resonant, and both adjusted to have the same, or substantially the same, time-period. The utility of this two-tuned-circuit arrangement was due to the fact that the secondary circuit not only received energy from the antenna, but being a resonant circuit, it permitted that energy to accumulate to the maximum and thereby efficiently operate the indicating apparatus, such as a detector and telephone, or in some cases, a telephone alone. This secondary circuit, also having the same time-period as its primary circuit, thereby permitted the two circuits to resonate harmoniously with consequent beneficial results.

This coupled-tuned circuit receiving apparatus (known as the Marconi type) proved so exceedingly useful in radio work that for many years it was not deemed possible to devise practical apparatus which was not of this type.

However, notwithstanding that this type was standard practice for many years, the art recognized that it possessed certain serious disadvantages. Attempts were made to improve the type so as to eliminate these disadvantages, but the latter proved to be inherent in the type.

The chief disadvantages were two: First, the inconvenience and delay involved in making fine adjustments in order to operate at best efficiency; and second, the inefficiency of operation due to coupling difficulties incidental to the transfer of energy from the antenna to the secondary circuit.

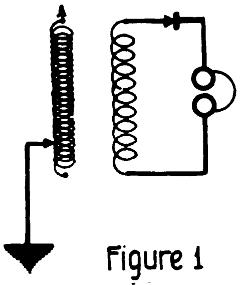


Figure 1

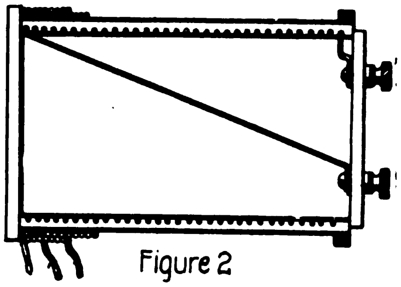


Figure 2

Figure 1—Location of the detector near an end of the secondary coil
Figure 2—Coil of the utilization circuit

The first disadvantage in the coupled-tuned circuit type was involved in the manipulative adjustments executed by the receiving operator. Each of the two circuits contained at least one frequency-determining element, such as a variable coil or a condenser, and generally both of such elements, and such elements in both circuits, were required to be accurately adjusted, in order to obtain the efficiency of the type, each time that a message at a different wave length came in from a distant transmitter. In fact, the highest efficiency of which this type was capable could not be obtained unless the operator first by trial adjustments put the two circuits into the same tune. This usually involved, first, an adjustment of the antenna circuit; then an adjustment of the secondary circuit; then a re-adjustment of the antenna circuit; then a re-adjustment of the secondary circuit, etc., sometimes including an adjustment of two or more elements in each circuit, so that, at best, it took a substantial length of time to put the apparatus into best condition. All this was a very serious disadvantage in practice, on account of the great importance of quick service. But this disadvantage was borne with, because it was inseparable from the efficiency of this type.

Thompson claims that in his arrangement there is equal efficiency with the coupled-tuned-circuit type without the necessity for any adjustments of a secondary circuit.

The second disadvantage in the coupled-tuned-circuit type involved difficulties in the coupling between the two resonant circuits. If this coupling was too close some of the energy accumulating and persistently oscillating in the secondary, was transferred back to the antenna, and re-radiated and wasted, instead of going forward to do useful work on the indicating apparatus—for the very fact that harmonious persistent oscillation of the two circuits facilitated the transfer of energy from primary to secondary, likewise facilitated the re-transfer of energy back from secondary to primary. On the other hand, if the coupling were then loosened in order to prevent such re-transfer, then that resulted in a decrease of the efficiency of energy-transfer from the antenna to the secondary. In practice a compromise was made by having the coupling neither very close nor very loose, *i.e.*, not so close as to cause a re-transfer of considerable energy back to the antenna, and not so loose as to prevent the transfer of a substantial amount of energy from antenna to secondary. This, however, did not remove, but merely alleviated, the difficulty, and there yet remained a substantial loss of efficiency because the compromise coupling was not close enough to transfer to the secondary all the energy supplied to the receiving antenna.

In the scheme here shown, there are no coupling difficulties because the accumulative action of the circuit supplied from the antenna is eliminated entirely, so that instead of a re-transfer of energy back to the antenna, the entire energy, transferred to the utilization circuit, is instantly consumed therein, and doing useful work in operating the detector.

In the best form of the coupled-tuned-circuit type, the secondary circuit included the secondary coil of an oscillation transformer, and a condenser, in series with each other; the condenser was in shunt or parallel between the detector and the secondary coil, the coil and condenser constituting a resonant cumulative circuit, this condenser being preferably variable to adjust the period of the secondary to that of the antenna; or else the inductance in the secondary was variable; or both the condenser and inductance in the secondary were variable, in order to obtain the best tuning.

In other forms of this coupled-tuned-circuit type, in order to reduce the manipulative operations of the receiving operator, the condenser has been omitted, and then the secondary coil was the only adjustable element in the secondary circuit. Of course, in all cases, the antenna is adjusted to be put in tune with the received waves.

In yet other forms of this type, no adjustment has been provided for the secondary circuit, but it has been given a fixed period approximating the range of commercial frequencies received on the antenna (no variability being provided for any reactance in the secondary circuit), the idea having been to eliminate all the troublesome secondary adjustments, but yet to retain the advantage of having the secondary more or less closely or broadly tuned to the antenna. This form has been termed the non-adjustable or "untuned" form, although the fact is that the secondary did have a "tune," as various investigators have shown. The difficulty with such attempted simplified form, however, was that the efficiency was reduced in proportion as the fixed period of the secondary was different from that of received signals to which the antenna was tuned. That is, although such a modified receiving set of the coupled-tuned-circuit type might be very efficient when the incoming waves at a period which happened to be the same or nearly the same as the fixed period of the secondary, yet the efficiency for receiving wave lengths higher or lower than the period of the secondary, was proportionately less, and the efficiency fell off rapidly for increases of difference in periods of secondary and received waves.

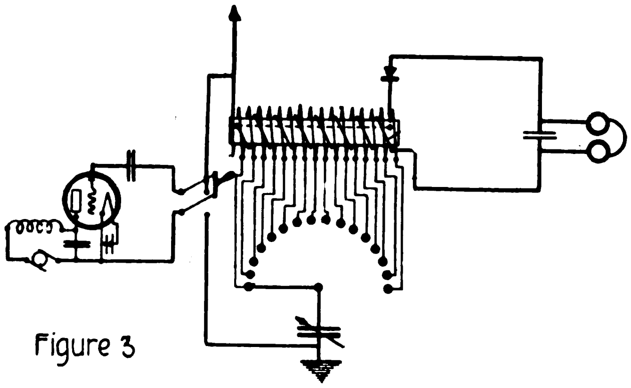


Figure 3

Figure 3—Showing arrangement whereby a vacuum tube produces oscillations to produce beats with an incoming signal

Thompson states that the inefficiency of the non-adjustable (so called "untuned") secondaries was due to the presence of distributive capacity yet existing in the circuit, even in cases where no condenser (lump capacity) was used in shunt to the detector and coil; that this distributive capacity was acting to make the circuit cumulative to a certain degree so that when it was attempted to simplify the operation by omitting an adjustable condenser paralleling the detector (in addition to the omission of adjustable inductances) such omission alone did not make the secondary circuit a non-resonant circuit, but simply deprived it of the mechanical advantage of being adjusted to have identically the period as that to which the antenna was adjusted. It possessed the disadvantages of a condition of resonance in the secondary without the ability to take advantage thereof. It, therefore, was nothing else than an inferior form of the coupled-tuned-circuit type, notwithstanding that this modification has been termed an "untuned secondary" type by many writers, simply because no adjustable condenser for exact tuning was provided in the secondary. The secondary was in fact tuned, although not to the exactitude required for the highest efficiency of the type.

In the practice of making secondary circuits without a condenser in parallel to the detector and secondary coil, it has been assumed, apparently, that the omission of this condenser removed from the circuit all capacity which was acting to make it a tuned cumulative circuit. The fact apparently has been overlooked that the circuit always possessed substantial capacity other than that of the omitted condenser—especially that capacity which is resident in the secondary coil.

It is Thompson's claim that the reason why the so-called "untuned," i.e., non-adjustable secondary,did not respond efficiently to the various wave lengths, was the existence of such distributed capacity. This distributed capacity of the coil provided it with ability to accumulate enough energy to be effective in re-acting on the driving circuit to such a degree as to make necessary the adjustment to the same period in order to eliminate such re-action effect.

It has been demonstrated that if the secondary circuit be constructed to have so little capacity (in parallel to the detector and secondary coil) as to be substantially non-effective in making the secondary a tuned circuit, then it is possible to operate a receiving station at maximum efficiency for all possible period of transmitted waves, without any reactance adjustments of the secondary whatsoever.

Under practical conditions, and with such minimum capacity in the secondary as the fundamental condition for substantial aperiodicity of the secondary, it is claimed that the same efficiency of reception at all present commercial wave lengths is obtained without any adjustment whatsoever of the secondary circuit. The coupling between the antenna and the utilization circuit should be sufficiently close to cause an instantaneous and complete transfer of energy from the antenna, and thereby cause the creation of maximum potential in the utilization circuit, without any necessity for (or any actual) substantial accumulation of energy, as in the coupled-tuned-circuit type; yet without any substantial loss of energy, and without any substantial re-transfer of energy back from the detector circuit to the antenna. This instantaneous maximum potential is created across the detector, and the resulting effect is passed directly, via the detector, to the telephone. Under these circumstances, the utilization circuit being actually aperiodic, and no energy being accumulated therein, there is none of the coupling troubles which existed in the couple-tuned-circuit type, for there is no re-transfer of energy back from the utilization circuit to the antenna, all the energy which was instantaneously transferred from antenna to utilization circuit being instantly employed in causing the indication of the signal. In all cases the non-adjustable utilization circuit has the same efficiency irrespective of the frequency of the transmitted waves. All this is particularly true when the natural period of the aperiodic non-accumulative utilization circuit is far below 300 meters—the shortest commercially used wave length—and when the antenna is adjusted above 300 meters.

In brief, the construction is such that substantially all of the energy received on the antenna is instantly passed on to its place of utilization without any interval of accumulation in the utilization circuit.

In putting his discovery into practice, Thompson reduces, so far as possible, the distributed capacity of the coil itself, and by so locating the detector in the circuit that any capacity which may exist in the circuit connections acts as in series with the detector and not in parallel thereto; that is, the detector is located as near as possible to an end of the secondary coil, as is illustrated in figure 1. In figure 2 is shown a coil of the utilization circuit especially adapted for an antenna coil of a given range of wave lengths; i.e., in this example 100 to 3,600 meters. For a receiver, the antenna and primary of which is to have a range of 100 to 3,600 when connected to an average ship's antenna, the following dimensions are suitable in connection with this scheme.

Around the primary core (see figure 2) of suitable insulating material, 4" in diameter and 7" long, is wound a primary coil consisting of 280 turns of wire, having a diameter over the insulation of approximately .05". This primary is "banked" in two layers. Suitable taps may be taken off as desired for purposes of adjustment of the wave length of the antenna circuit. Provided with means for sliding all the way inside of the primary core is the secondary cylinder, which is 3½" diameter and 7" long. Around this cylinder is wound a single layer secondary coil, consisting of 70 turns, having a diameter outside of insulation of .05", each turn being separated from each adjacent turn by a distance equal to the thickness of the wire. The extreme ends of the winding are connected to binding posts which in turn are connected to the detector and telephone (figure 1). The novel feature of figure 2 is, according to Thompson, that a high inductance is had here without the capacity normally corresponding thereto.

In figure 3, an arrangement is shown whereby a vacuum tube may be connected for the production of oscillations which are to produce beats with any incoming signal. Here the antenna circuit controls the frequency of the oscillations of the vacuum tube and also, as before, the frequency to which the antenna circuit is tuned.

Many efforts have been made during the past few years to simplify the operation of a receiving device. The foregoing is a very good example of the trend that these efforts have taken. A solution such as this, however, would not seem to be the final solution.

Constant Speed Regulator for Series Motor

(Continued from page 14)

wireless transformer, providing the auto-transformer is correctly designed. A ten-ohm rheostat is also included in the circuit to the motor for close regulation of the compensating voltage in each case.

The auto-transformer, for the usual type of high-speed series motor using about 50 watts, consists of a laminated iron core one inch square in cross-section and three by seven inches outside dimensions, as shown in figure 2. On one leg of this core are wound 800 turns of No. 22 D.C.C. wire, a tap brought off, and an additional 50 turns on top of this. In some cases, with larger motors or where the voltage drop is already excessive it may be necessary to use more than 50 additional turns, but these can readily be added after the device is completed. The line voltage is connected to the 800 turns and the motor is normally connected to these also giving it the regular line voltage, but when the key is pressed the compensating winding is connected in circuit.

The double contact relay can be made from any available parts the experimenter may possess. The magnets should be of about 200 ohms resistance and have laminated cores if possible. The contacts need not be very large as only one-half ampere of current is carried by them.

The whole device is so simple and inexpensive that it is recommended to any amateur who desires a constant, readable, spark note.

EXPERIMENTERS' WORLD

Views of readers on subjects and specific problems they would like to have discussed in this department will be appreciated by the Editor

An Original Aerial Switch

By Thos. W. Benson

FIRST PRIZE, $10.00

THE writer has had occasion to handle many types of aerial switches, from the ceiling type operated with cords to the foot operated switch, and few, indeed, are really satisfactory. The usual D. P. D. T. switch operating through an arc of about 60°, in common use, makes a fine appearance but it is unhandy to throw upward, requiring some effort when the clips are tight.

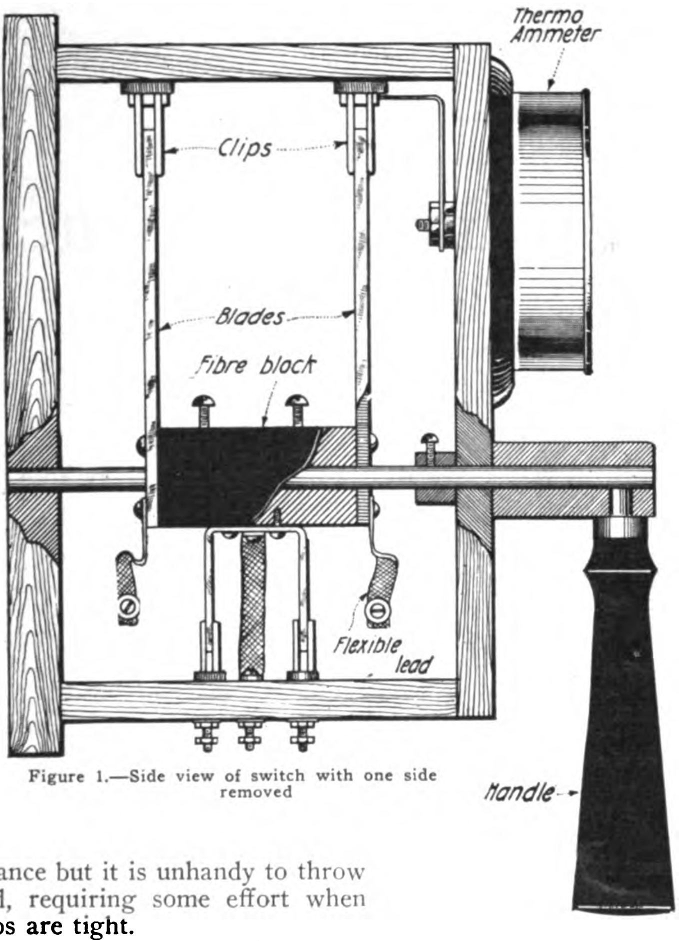


Figure 1.—Side view of switch with one side removed

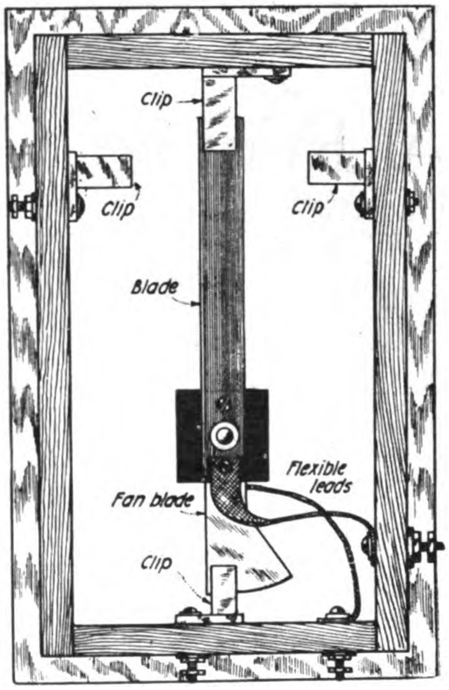


Figure 2.—Sectional end view of switch showing arrangement of clips

To overcome these defects the switch described was designed and worked splendidly. There are several advantages, the most important being that either a downward or upward thrust of the hand will throw the switch either way. The switch, when mounted over the key is remarkably easy to throw. When reaching for the key, the hand naturally throws the switch with the minimum effort.

It includes a device for closing the primary circuit and starting the rotary gap. Other attachments are not advised as they lead to induction currents in the receiving set. A convenient place to mount the thermo-ammeter is over the switch. A special arrangement of contacts allows this meter to be up in the circuit when desired. This eliminates an extra switch used for short circuiting the meter. The circuit used is rather novel, the problem of insultation is solved by receiving through the secondary of the oscillation transformer. Though not exactly new, the method is not used as extensively as it deserves to be.

The constructional details of the switch are given in the attached illustrations and due to its simplicity requires little, if any, explanation. The dimensions will vary slightly with the apparatus available, hence only general data is of any practical value.

The switch blades are made from copper strips 4" long ⅛ x ½". These are held 2" apart by a block of bakelite or fibre. A hole drilled through the fibre passes a brass rod to actuate the switch. A hole larger than the rod drilled in the copper blades prevents them making contact with the brass rod. The insulating block is fastened to the rod by two machine screws running through the block.

Two copper Ls attached to the lower side of the block, act as blades for controlling the primary supply current and the rotary gap motor. Connections are made to all the blades by heavy stranded wire, No. 14 serving for the smaller blades, a braided ribbon for the aerial circuit blades. These are clamped under the screws and soldered securely in place. Three binding posts on the bottom of the box allow of connections to the small clips. A heavy pair on the lower right hand side is for connection in the aerial circuit.

The arrangement of the clips is shown in Fig. 2. The box is 4" wide; two switch clips being mounted on both sides of the box 2" apart to receive the blades, the clips on the right being short circuited by a copper strip, those on the left having binding posts on the outside for connecting to the receiving set. Midway on the top of the box, and arranged so as to make contact with the blades, are mounted two other clips. These are shaped so the blades will enter easily from either side. Heavy leads are run from these posts to the thermo-ammeter on the front panel.

The actuating handle may take different forms depending on the desire of the builder. A small hand wheel may be used or either of the ideas shown. In one form a round block of fibre is drilled to pass the rod and tapped to take a switch handle projecting downward. The thread in the switch handle clamps again a flat side field on the brass rods. or two switch handles may be threaded into the fibre cylinder projecting on either side.

The switch is mounted on the wall or back of the operating table, six inches above the top. With the single form of handle a sweep of the hand will throw the switch. The double handle requires downward pressure on the proper side to operate the switch. By setting the blades in the centre a reading can be taken on the ammeter, the width of the primary and gap circuit blades permitting the circuit to remain closed.

The wiring diagram in figure 3 shows how the circuits are controlled. The switch acts to open the aerial circuit and connects in the receiving set thus receiving through the secondary of the O. T. Leakage of the sending current is impossible. The switch is connected in the ground lead of the set so the lead can be run directly to the O. T. simplifying the wiring. The thermo-ammeter is connected in the ground lead, the proper place for this instrument.

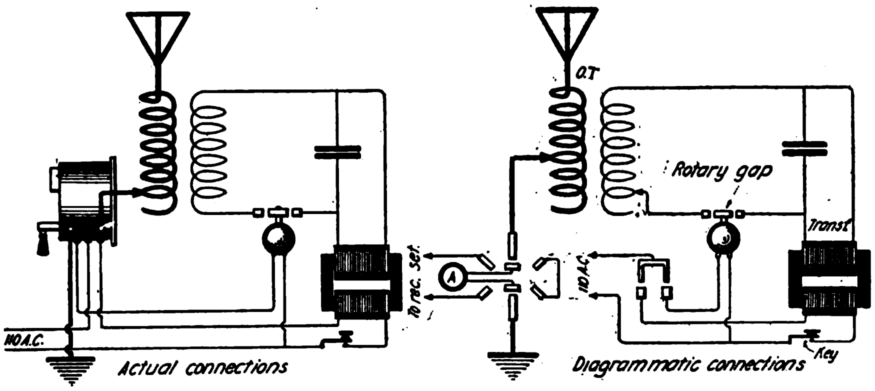


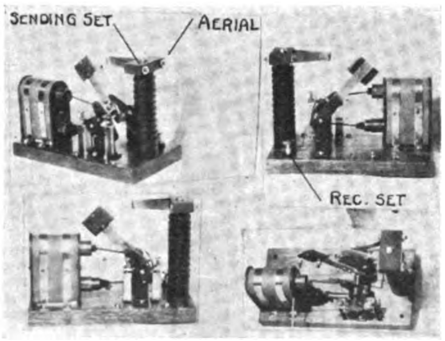
Figure 3.—Wiring diagrams showing how the circuits are controlled

A Remote Control Antenna Switch

By Omer E. Cote

SECOND PRIZE, $5.00

A GREAT many amateurs will find it possible to increase the efficiency of their transmitters considerably if they locate the transmitting apparatus at a point which is remote from their receiving apparatus. The amateur is not always able to choose the location for his apparatus, and is usually allotted a room somewhere in the garret. Those who have had experience with the transmitter located in the garret have learned that they do not function as well in such a location as they would near the ground. The design of a remote control antenna switch which may suggest possibilities in this direction, is therefore offered. This switch, as constructed, is suitable for powers to ½ KW. For higher power a longer strip on the switch blade will be required. The switch, as designed, merely changes the aerial connections from "receive" to "send" and vice versa, the ground connection being on both transmitter and receiver at all times. It is necessary, however, to disconnect the ground from the receiving set when transmitting. This may be accomplished by having a small porcelain base single pole switch near the receiving apparatus which is to be open when the transmitter is in operation. This method simplifies the construction of the antenna switch itself, although the ingenious amateur will be able to so alter the design as to meet any of his requirements.



Various views of the switch

Figure 1 shows the base which may be made of mahogany or any wood. Bakelite or hard rubber is not necessary, since all the high voltage terminals as well as the receiver terminals may be mounted individually on hard rubber or bakelite. This method will save considerable expense. Dimensions are clearly shown on the base drawing. Standard binding posts may be substituted for the three No. 8 machine screws which are called for in connection with this base. Machine screws will serve every purpose, however, since, once the connections are made, they are never changed.

Figure 3 shows the standards for the shafts. These may be made of iron or cold rolled steel. Two are required. A coat of dull black enamel will furnish a neat appearance. Figure 2 is the magnet rotator arm. The hub may be made of either cold rolled steel or of brass and is fastened to the long fibre piece with two No. 4-36

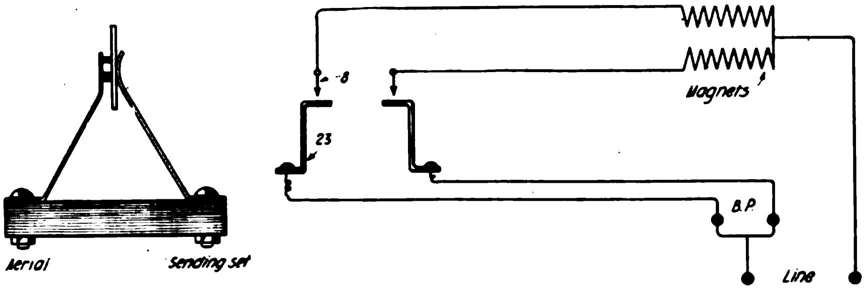
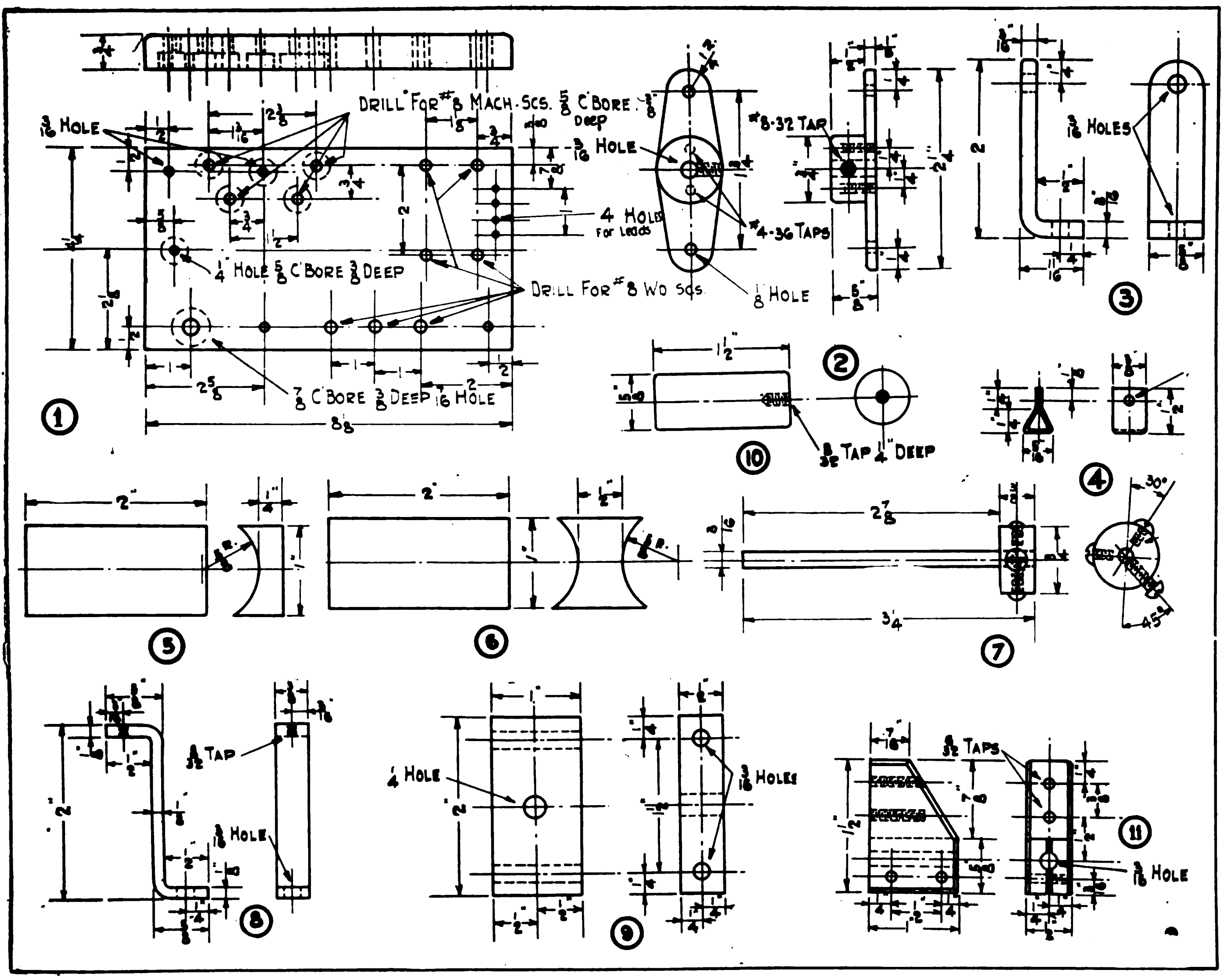


Figure 25.—Circuit diagram showing connections



Figures 1 to 11.—Constructional details of various parts

round head machine screws. An 8-32 machine screw in the hub itself is used for a set screw in holding the arm to the shaft. One arm is required.

The shaft shown, figure 7, is either brass or cold rolled steel and at one end is fastened the magnet current breaking attachment. The cam is made of hard rubber or bakelite and the two 4-36 screws are 1/4 inch long, as they should not touch the rod. The other screw can be a 6-32 machine screw to hold the cam to the rod. It is important that the point of this set screw fit on a flat spot on the shaft to keep it located at all time; otherwise the shifting of the magnet would soon twist the cam out of alignment.

Figure 4 is the clip fastened by a machine screw to the magnet core, figure 10. The 1/8-inch hole is for the connector arms, figure 15. The arms are made of iron wire to the sizes shown. Figures 5 and 6 are made of wood and are the support for the magnets. Figure 5 goes on the base, then the first magnet, then figure 6, then the second magnet.

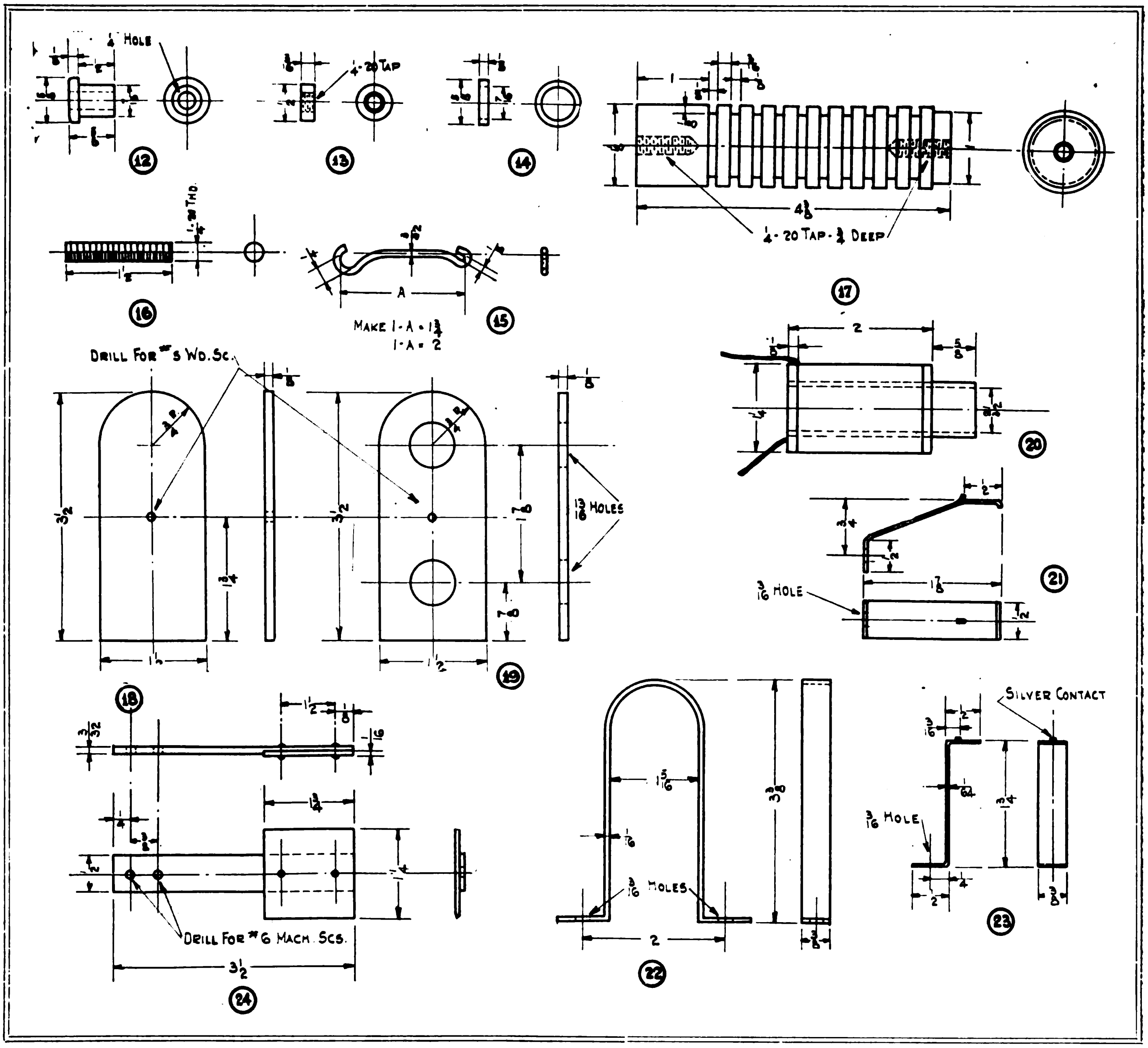
The magnets are shown in figure 20. The solenoid is a piece of brass tubing which is covered with varnished linen before winding the wire. The magnets are wound each with 1500 turns of No. 27 enamel wire which gives a resistance of about 20 ohms. The ends are of fibre.

These magnets are fastened in place in the following manner. The blocks 5 and 6, having been placed between the magnets, a piece of fibre about 1/32 inch thick and cut 2 1/8 inch wide, is put around the magnets before putting on the straps, figure 22.

If it happens that these straps do not hold the magnets good, the latter are wound with a few wraps of tape to increase their size; it is important that they be fastened very tight so that they will not move when working. The magnets being 2 inches long and the fibre covering 2 1/8 inches, leaves at the outer end a space of 1/8 inch for bringing the leads down and through the base. At both ends are the parts 18 and 19, which are made of fibre and held in place by wood screws fastened into part 6.

Figure 11 is made of bakelite and holds the knife blade. As can be seen in the photos, this blade is entirely insulated from the shaft. A connecting wire made of many strands of fine wire, to be flexible, is fastened to the knife blade at one end and the other end is fastened to the insulated terminal on the base.

This terminal is shown in figures 12, 13, 14 and 16. Figures 12 and 14 are made of hard rubber or bakelite, while 13 and 16 are made of brass. A knurled nut is used to connect the lead wire. Figure 17 is the insulating support and is made of either hard rubber or bakelite, while part 9, which is fastened on top with a 1/2-20 round head brass machine screw, is also made of the same material. The 3/16-inch holes in part 9 are for 10-32 round head machine screws., 1 1/4 inches long, which hold the springs, part 21, in place. Part 17 is fastened to the base with a 1/2-20 machine screw.



Figures 12 to 24.—Additional constructional detail

Part 21, two of which are required, is made of spring brass or copper.

Figure 8 is a brass standard which holds the contact screw. Two of these standards are required. The contact screws are 8-32 round head brass machine ½ inch long with a silver or platinum contact at the end. Two check nuts are also used with these screws.

Figure 23 is the spring standard, two of which are required, and is actuated by the cam at end of shaft.

The switch blade, figure 24, is made of copper and the insulating strip at the end is of bakelite held by two brass pins.

Figure 25 shows the connections.

1 KW. Antenna Switch

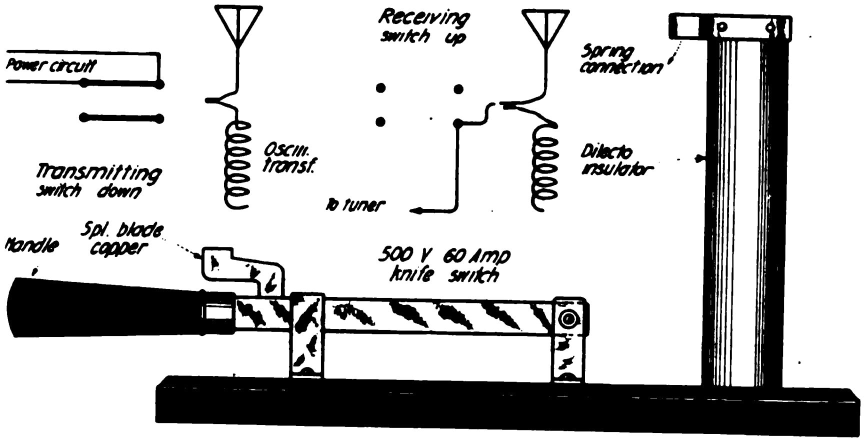
By M. P. Koopman

THIRD PRIZE, $3.00

THE design of the following described switch has been worked out with the idea of reducing the machine work to a minimum, as most amateurs have not the facilities of good tools.

The sketch shows the connections for the "send" position and "receive" position and side view of the switch. The main part of the switch can be bought new or secured second hand and is a 500-volt 60-ampere knife switch with high jaws, front connected. This switch is then mounted on a slate base of suitable size. Also on the same base a dilecto rod insulator is mounted as shown. In a 1-kw. set the rod should be about 8 inches high, and for a ½-kw. set about 5½ inches high.

At the top of this rod insulator, two contact springs are placed, and so adjusted that they touch each other with good contact at all times that the special blade contact is not between them. One of these contacts is connected to the antenna and the other to the transmitting loading inductance or oscillation transformer. When the switch is down, the special blade is not between



Side view of the switch and connections for "send" and "receive"

these two contacts and direct connection from the antenna to transmitter is made. At the same time, the auxiliary contacts on the knife switch may be used to start the rotary gap and close the primary of the transformer circuit.

It is noticed on the drawing that the special blade on the switch is insulated on one side. Then when the switch is up, the transmitter is insulated from the antenna, and connection from the antenna is made through the special blade down through the switch blade to the switch hinge on one side.

Such a switch is very simple, very easily constructed and will give excellent operation.

70-Foot Mast for Umbrella Antenna

By M. P. Koopman

FIRST PRIZE, $10.00

THE mast and antenna described was erected some time ago (before the war) for 200-meter transmission, and it gives very good results. Many people claim that the umbrella type antenna is the best for transmitting, especially on low wave lengths.

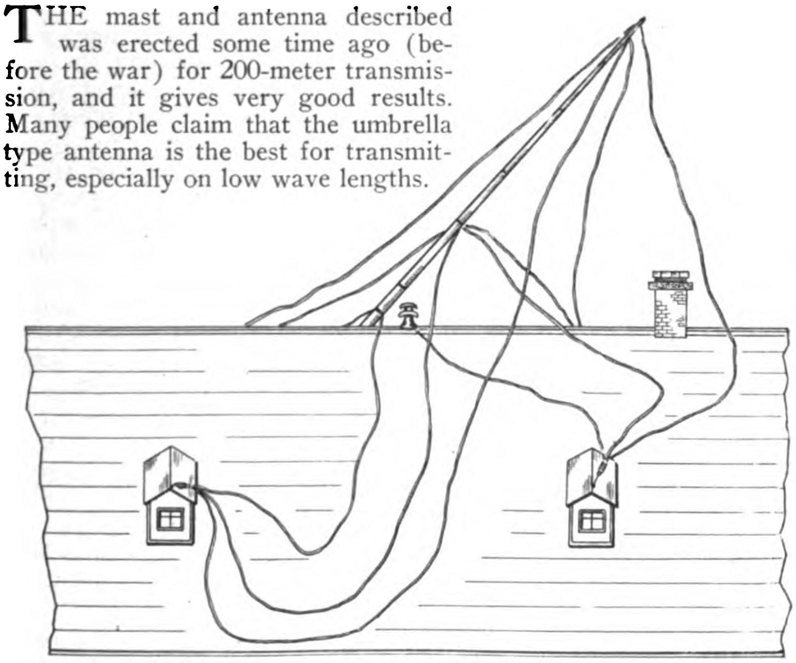


Figure 2.—Showing method of erecting the mast.

Inasmuch as the amateur has to pay quite a little money for his mast and then an additional sum for the antenna, by incorporating the antenna and mast together, this total is reduced considerably. Furthermore, this type, besides being efficient for transmitting, occupies very little space and may be erected on one's premises where the amateur is confined to his own residence.

The material necessary is itemized as follows: Eight 10-foot lengths of conductor pipe 3 inches diameter, No. 26 standard gauge, extra heavy galvanized; one petticoat insulator, porcelain, glazed, should be rated for at least 80,000 volts for wooden roofs and 120,000 volts for tin roofs; four large strain insulators, voltage will depend upon the power and wave-length that the set is to be worked at; four heavy screw eyes for anchors, screw should be about 7/8-inch thick and 3 inches to 4 inches long; antenna wire, seven strands of No. 22 B. & S. gauge silicon bronze, preferably tinned. Quantity can be figured out for the particular installation. Muriatic acid for soldering, solder (half tin, half

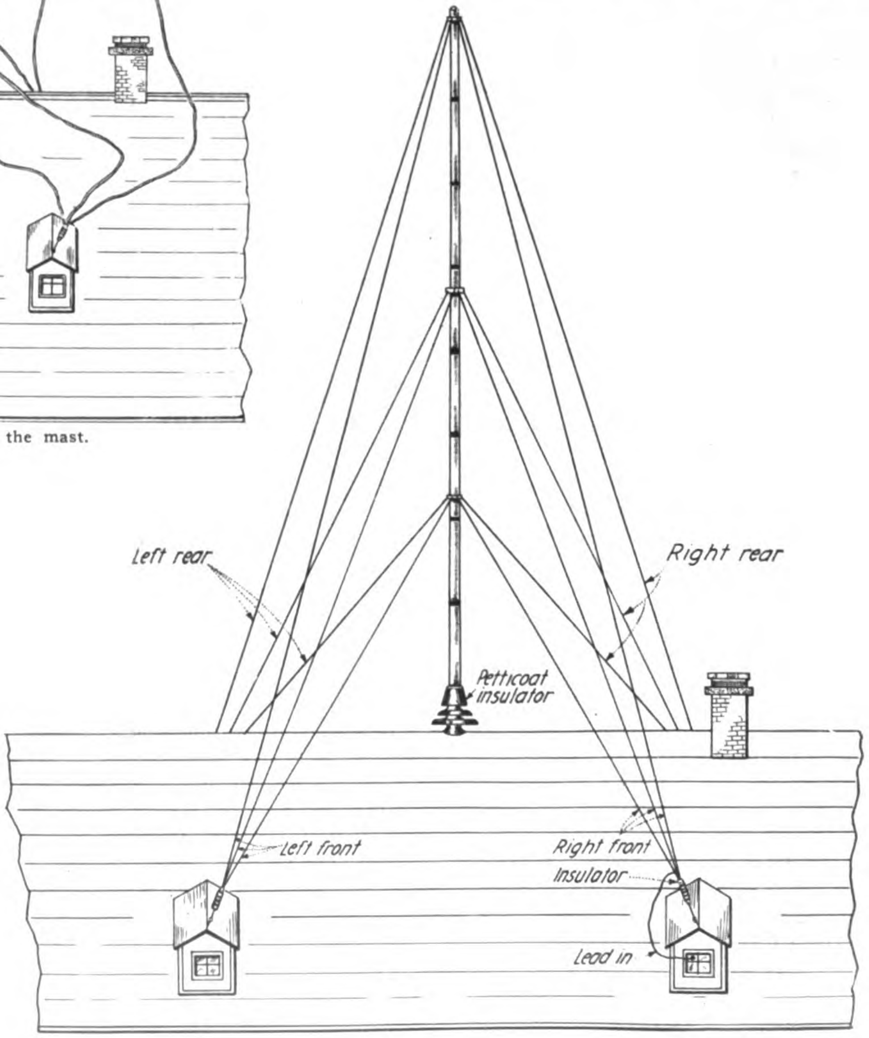


Figure 1.—Showing mast in position and location of the guy wires and lead-in wire

lead), cotton waste and rubber tape, little shellac or varnish, some asphaltum.

The third sketch shows the details of the petticoat insulator. This should be installed first, in the center of the four anchor posts that will be selected. As shown, the pin that screws into the insulator, is one that has a large wood screw at the other end. This wood screw is screwed deep into the ridge pole. It will be found that the ridge pole is a heavy beam and a hole will have to be drilled for the wood screw. Before screwing it in, the hole should be filled with asphaltum and later asphaltum spread all around the hole to prevent the roof from leaking. The four anchor wood eye screws are then screwed in their respective places in a like manner. It must be ascertained that the anchor wood eye screws are fastened into beams and not into the roof, which is only ½-inch stock.

Conductor pipe comes small at one end and large at the other and in 10-foot lengths. There are eight sections in all. While on the ground, these sections should be placed inside each other for 18 inches, making a total length of about 70 feet. It will be found that they will have to be forced in order to go in that 18-inch and that they will not go in much further without undue effort. Now that the sections are fitted together, these joints should be very thoroughly soldered, using a gasoline blow torch, muriatic acid diluted with water for soldering flux, and good solder. It may be advisable to tin the joints before forcing them together and then heating with the blow torch, making the soldering operation easier. At the top section, the end is hammered over to prevent water running down the inside. This should also be soldered to make it water proof.

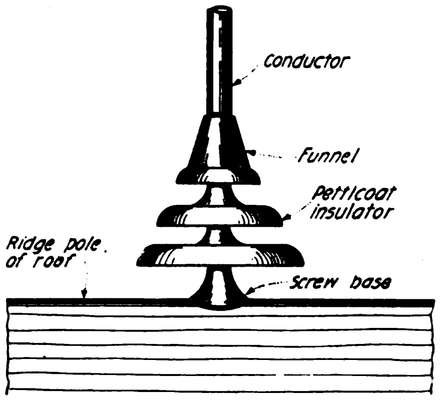


Figure 3.—Details of the petticoat insulator installed in the center of the anchor posts

At the end of the bottom section, an ordinary 8-inch heavy gauge gasoline funnel is inverted. This gives a means of evenly distributing the weight of the mast on the petticoat insulator. This funnel need not be soldered to the bottom section as it will center itself.

The antenna wires should be cut about 10 feet longer than the exact size required in order to have a working margin. The lower antenna wires are placed 25 feet up the mast, the center wires 50 feet up the mast, and the upper wires at the top. At that place where the wires are fastened to the mast, they should be wrapped around very securely and soldered carefully. After feeling that they have been soldered properly they should be covered with asphaltum as far as they are soldered and all over the mast where there is soldering. This will prevent corrosion, at a later part of the season.

After the wires are cut to size and soldered to the masts, they should be so placed that they will not cross when the mast is lifted up alongside the house. Figure 2 shows the first erection operation. Most houses are from 30 to 40 feet high, and when the mast is hoisted along side the house, it will stick about thirty feet above the roof. The best way to raise the mast is to fasten long ropes to the end of each set of three wires and have a man hold each set. A block and tackle can then raise the bottom of the mast to the top of the roof and be placed on the petticoat insulator, while the four men steady the mast by holding the guy wires. Afterwards, one set of wires can be fastened to its anchor screw eye and the others following.

The whole outfit does not weigh more than sixty to one hundred pounds and no difficulty will be experienced in raising if there are five men available. Larger masts of the same type could be built, but the natural wavelength would be too great for 200 meter transmission without a series condenser which is not desirable.

100-Foot Radio Mast

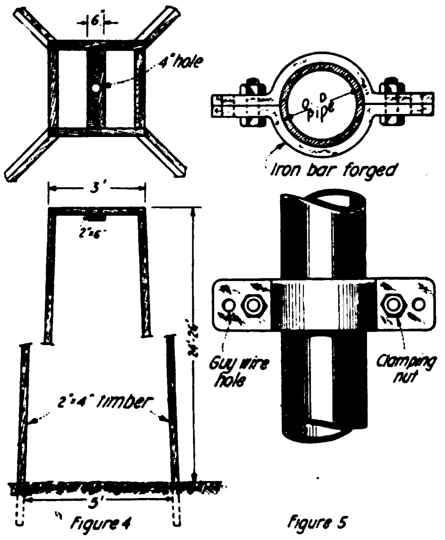
By L. D. Dillenback

SECOND PRIZE, $5.00

A YEAR before the war, an excellent mast was put up in New England by a few amateurs, 100 feet high, made of second hand iron pipe and second hand guy wire that was purchased very reasonably. Of course, prices have gone up about 200 per cent in iron pipe and wire, but even now a good mast could be put up reasonably.

This particular mast, figure 1, was used to support one end of an aerial, the other end being supported by a 130-foot pine tree which was located about 100 feet away. The antenna was strung between these two points, made T type and the fundamental was about 170 meters.

The technical data at the end of this article show the hardware that will be necessary, with the exception of the pivot, guy clamps and anchors, or "deadmen" as they are called in telegraph practice. When purchasing the pipe, new or second hand, look for the manufacturer's mark. The year is also there and either a B or an L after the year it is manufactured in. B means butt welded and L means lap welded. Lap weld should be secured if possible as this will not buckle so easy and is much stronger. Furthermore, galvanized pipe should be secured. After buying second hand pipe, test the pieces by dipping them into a saturated solution of sulphate of copper and watch for defects in galvanizing, or spots where the galvanizing is disappearing. Black spots show where the galvanizing is weak or incomplete. In case the defects show up, it will be best to paint the pipe with black asphaltum or a graphite paint which will last some years.



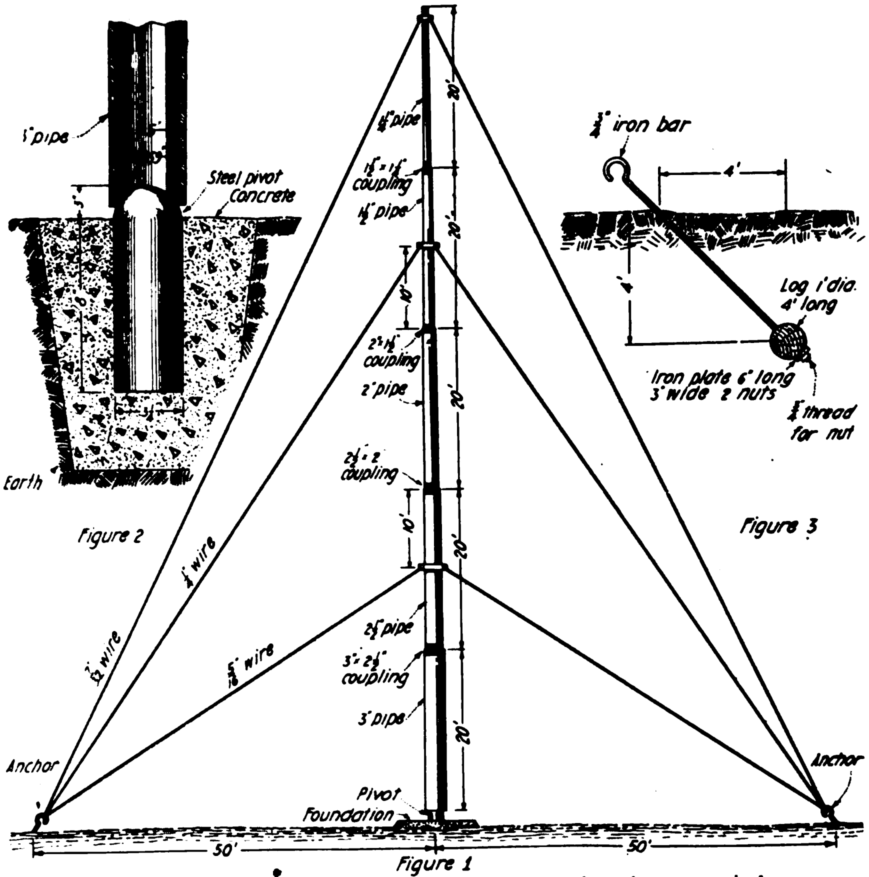
Figures 4 and 5.—Frame for concrete foundation and details of guy clamps, respectively

The guy wire should also be bought galvanized or it will not last any length of time at all. In case it is bought second hand, it should be tested by stretching out and inspecting closely. Both new and second hand wire should be greased thoroughly with a good graphite grease before being erected. Care should be taken at all times to see that no kinks are made in the wire, for when these are pulled taut the wire will break easily.

The first operation is to carefully select the location of the mast, or the masts if there are two. The position of the pivot should be marked with a stake, and the position of the anchors should be laid out and marked with stakes. The pivot is then set in concrete, figure 2, and allowed to stand at least a week. During that time the anchors can be put down, figure 3, guy wires cut to length and other material all put in accessible places. A light frame of wood timbers, 2 x 4 inches, should then be erected at the pivot foundation, about 24 to 26 feet high, figure 4.

After the concrete around the pivot is dry and hard and the deadmen are laid and all the wires cut to size, etc., erection may start. It is suggested that six men be available and that they start in the morning. Then, in case things go slowly for some unforeseen reason, the work may be completed in a day and will not have to be left unfinished during the night with chances of a storm coming up to wreck the mast.

The 1¼-inch pipe is first lifted through the hole in frame and the upper guy wires fastened to the guy clamp, figure 5, for that pipe. The 1½-inch pipe is then joined to the first section by the reducing coupling. The 1½-inch section is then lifted ten feet, its guy clamp and the middle guy wires attached. That section is then lifted ten more feet and the 2-inch pipe coupled on with the reduction coupling. During this time, one man at each of the four anchors is paying out the guy wires. It may now be necessary to put a block and tackle on the pipe to hoist it, as the total weight without guy wires is about 450 pounds. The two-inch pipe is raised and coupled to the 2½-inch pipe and that raised ten feet more and its guy clamp and the lower guys fastened on. The 2½-inch pipe is then raised ten feet and coupled to the last section, the three-inch pipe. The three-inch pipe is then settled on the pivot and full attention given to the guys.



Figures 1, 2, 3.—Mast erected, concrete for pivot and anchor fastening, respectively

If the guys are kept steady when the sections are raised, it will be found that no trouble will be experienced. However, jerks or unsteadiness increases the possibility of trouble. In those spots where the guy clamps are fastened to the pipes, the pipe should be knurled with a center punch and hammer, to prevent slipping when strains are placed on them.

The guys should then be taken up temporarily by hand by each man. Later, one man should go some distance away and signal each man at the different anchors to take his guy in or out the proper amount to get the mast exactly perpendicular. Then two or three men should go around each anchor and draw the guys as tight as possible.

Of course, before the mast is put up, a tackle and rope should be fastened on the first 1¼-inch section to hoist the antenna on. After the antenna is raised, further adjustments on the guys will be necessary to compensate for certain unusual strains that may be encountered according to the height of the other supporting end of the antenna.

Exclusive of the labor, this mast could be put up for about $75 to $100 and would not have to be overhauled for at least three years, so it would cost about $30 a year.

HARDWARE REQUIRED—TECHNICAL DATA

Wrought Iron Pipe, Galvanized, Standard Lap Weld

Length	Size	List Price per Foot	O. Dia.	I. Dia.	Lbs. per Ft.	Wght. 20 ft., Approx.
20	1¼	.23	1.660	1.363	2.272	44
20	1½	.275	1.900	1.604	2.717	54
20	2	.37	2.375	2.060	3.652	72
20	2½	.585	2.875	2.460	5.793	114
20	3	.76½	3.500	3.059	7.575	150

Total weight of pipe (lbs. approx.)....450

REDUCING COUPLINGS:

Size	Approx. Length	Approx. Weight
3 -2½	3"	3 lbs.
2½-2	3"	2.2 "
2 -1½	2½"	1.3 "
1½-1¼	2¼"	.8 "

1-1¼" End Cap.

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An Easily Constructed Mast

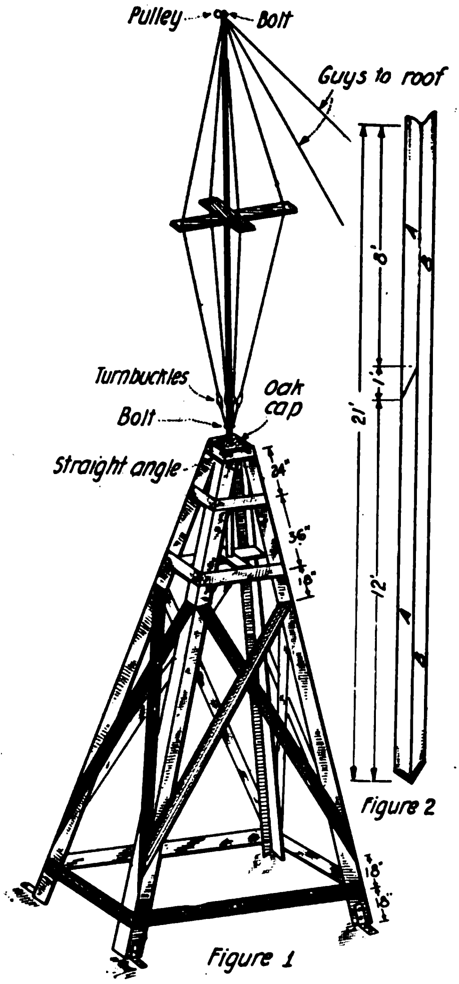
By Frank H. Mulcahy

THIRD PRIZE, $3.00

THE following is the description of the mast which I use at my station, formerly 2AIL, now 2NG, located at Park Avenue and 169th Street, New York City.

The material required for this type of mast consists of three bundles of furring strips, one twenty-foot length of ¾-inch galvanized iron pipe, four iron straps 2 feet x 1½ inches x ¼ inch each, four 4-inch straight angles, six dozen 2½-inch round head bolts, twelve dozen washers, one dozen 2-inch wood screws, two pounds of 2-inch nails, a galvanized iron pulley, four turn buckles (small), and about 200 feet of steel guy-wire. When I built the tower the material cost me about eight dollars.

To begin with, the corner members are formed as shown in figure 2. Two furring strips are prepared as A, and two as B. These are nailed to form an "L", placing a small section at each end so as to bring the joint at different places in the member. Two corner members are laid on the ground, touching at one end and eight feet apart at the other. Eighteen inches from the open end a piece of furring is bolted to each corner member, and a few inches from the top a four-inch straight angle of iron is fastened. Two feet and five feet respectively from the top two more pieces of furring are bolted. Then six and one-half feet from the top and three feet from the bottom two pieces of furring are bolted forming an X. This complete operation is repeated and a second side is formed. Then placing these sides so they meet at the top and are eight feet apart at the base, the remaining sides are bolted to correspond to the two already formed. A 4-inch x 4-inch x 1-inch oak cap is nailed on the top and a hole drilled to fit the outside diameter of the pipe. Connecting the mid-points of the opposite cross-bars that are five feet from the top, a strong cross is nailed, at the intersection of which a hole is drilled part way in the upper piece to form a socket for the pipe to rest in. A washer is placed under the head and nut of each bolt.



Figures 1, 2.—Constructional view of mast and details of corner members

A hole is drilled in the pipe two inches from one end and six feet from the other end. A bolt is placed through each hole as a fastening for the ends of the guy-wires. Two three-foot pieces of strong wood are nailed to form a cross as indicated in figure 1, a hole drilled at the intersection for the pipe and a small hole at each end for the guy-wires. The guy-wires are made tight to the bolts and through the holes in the cross by turn-buckles placed in each guy near the bottom. To the top of the mast a galvanized iron pulley is fastened and from the same point guy-wires go down to the roof to compensate for the pull of the aerial wires.

Four iron straps, 2 feet x 1½ inches x ¼ inch are bent to the angle which the foot of the tower makes with the roof, and three bolts fasten one leg of the angle to the tower and three 2-inch wood screws fasten the other leg to the roof. Roof cement packed around this strap will prevent rain from leaking through.

The tower can be built on the ground, disassembled and reassembled on the roof. As my roof space did not

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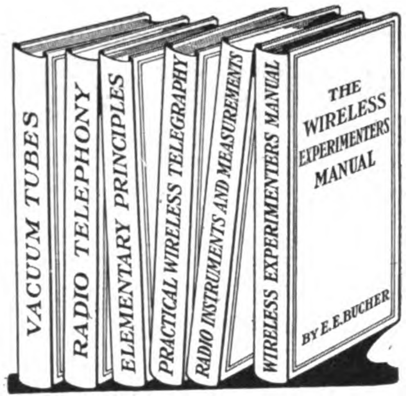
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permit the placing of the mast in the tower before standing it upright it was necessary to bolt the tower in place first, leaving the mast rest on the roof in the center of the tower with the top end passing through the hole in the top of the tower. Before placing the mast in the tower the guy-wires are loosened and the cross pushed to the top of the mast. Two men now climb up the tower, which is strong enough to support them, and raise the mast until it rests in the socket on the cross-arm five feet below the top of the tower. While raising the mast the cross should be brought down from the top of the mast until it is seven feet from the top and then left there. After the mast is set in place the guy-wires are again fastened and the construction of the tower is completed. A coat of light gray paint gives a steel-like effect.

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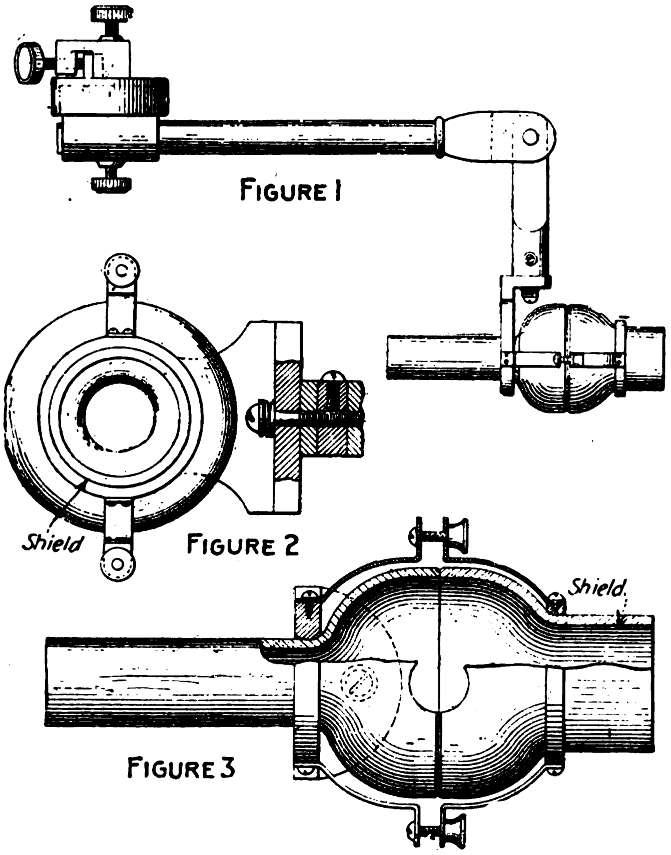

Figure 1.—Side view. Figure 2.—End view. Figure 3.—Top view.

The purpose of this device is to provide an X-ray tube holder which is adjustable to all positions and which at the same time acts as a shield enabling the rays of the tube to be projected only through the end of the shield, and thus protecting at the same time the patient and the operator from ill effects resulting from undue exposure to the rays.

Explanation—January "Age" Article

WITH reference to the article by Chas. R. Leutz in the January issue, covering the construction of a VT detector and 4-stage resistance coupled amplifier, the circuit diagram shown in Fig. 8 should be altered to include a connection joining the terminal marked "wing" to the positive terminal of the common B battery.

With reference to figures 11 and 12, it is understood, of course, that in order to get proper action when the circuits shown in above figures are connected to the amplifier, it will be necessary to provide some means of coupling the detector circuit to the amplifier. This may be effected most easily, perhaps, by connecting a pair of telephones, or, a single telephone piece across the grid-filament terminals of the amplifier.

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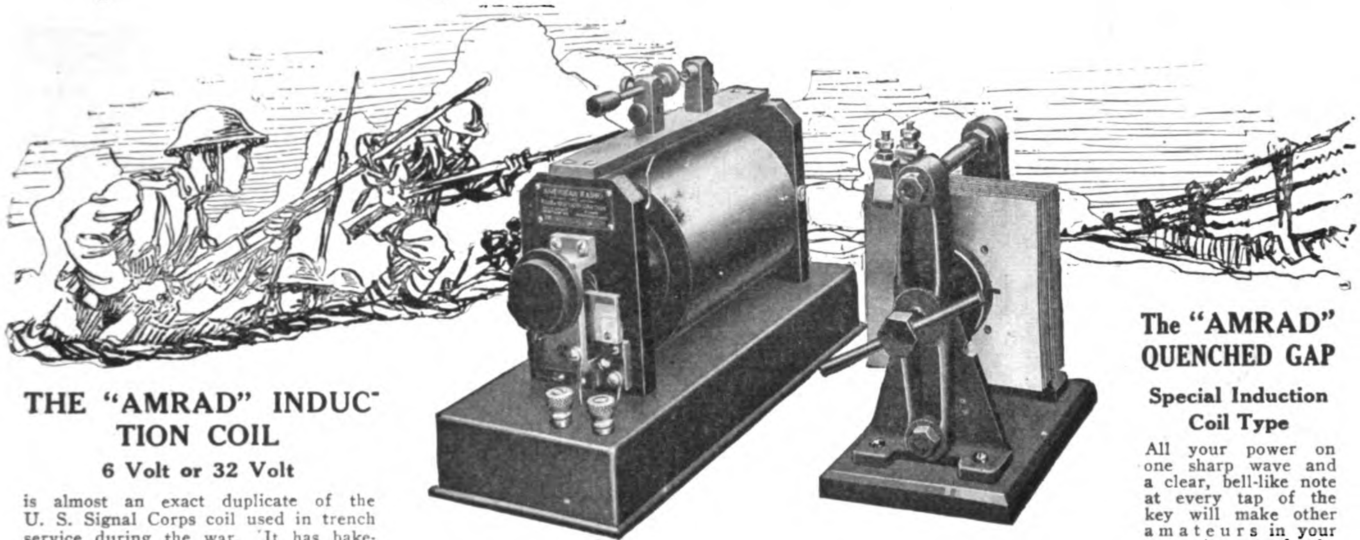

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Getting Results

By P. F. Geagan

WHENEVER and wherever radio operators, amateur or professional, congregate, the conversation will nearly always swing around to a discussion of the merits of different appliances. Apparatus, circuits, antennae, etc., are discussed pro and con, and each one of the participants holds decided convictions as to what is good, fair, and bad, among them. Of course, each boasts the particular arrangement which has given in actual use the best satisfaction to him, and invariably condemns whatever has failed in his case to deliver the goods.

There is always an arrangement of circuits which one enthusiast boasts to the skies, giving instances of long distance work, unbelievably loud signals, or great selectivity of tuning. His claims are ridiculed by another for the reason that he has given it a thorough trial himself, and being unable to get anything out of it, returned to his own pet hook-up, the only one in captivity, all others being base imitations. A third member of the group pities both of them, since he knows from actual experience that neither one of the layouts they are arguing over can compete with his lashup, which, take it from him, is the only one extant that will . . . etc., etc., etc. And so on to the end of the meeting.

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post) is the probable cause for the government inspector who views the quivering remains wondering whether it is an exhibition of lightning arresters or a miniature reproduction of No Man's Land.

Experimenters who spend a number of perfectly good and healthy dollars in the purchase of Litz wire in order to reduce the high frequency resistance of their circuits, connect it carelessly and loosely to what should be termed a "subterranean binding post"—that is, one which requires extensive excavation of dust and disturbing the clutter of cigarette ashes and the other things around it in order to correctly place an inoffensive and long suffering wire. Then the wire is carefully draped around the table in imitation of the course of the Mississippi River, the remainder which the small fifteen foot table will not accommodate being looped up on a gas jet. The experimenter then pounces upon the helpless apparatus which has endured much, and proceeds to prove that Litz wire is a snare and a delusion. He spent his good money for it and imagines that he has given it a fair trial. Results? Nothing from nothing equals their numerical value. And so, when later on, he meets with station owners or operators who extol Litz wire, he opens wide his face and shames the hyena with his mirth. You've met the type!

The number of weird schemes and queries submitted to the editorial staffs of the magazines devoted to radio, indicate how far in advance of the scientists are some of our amateur station owners. At the moment I have in mind—with apologies to Wool Soap Eddie—one who sent in a letter with a sketch of a row of trees standing beside a house with a wire running from tree to tree and into the house. The height of the trees, the distance apart, the height and length of the wires, were all carefully set forth, even the information that the trees were descendants of the maple family, was included. It was requested that the wave length of this multiple tree antenna be furnished.

As the writer neglected to supply information as to the number of pickets in the fence surrounding the house, the editors were unable to answer the question.

Much of the hit or miss trust to luck method of assembling and handling the transmitter also naturally results in as many different degrees of failure. Transformers are often connected to a condenser capacity of a greater value than they are able to supply. Loose connections, carelessly arranged power circuits, and indifferent antenna and ground connections, all contribute to negative results.

If a few simple rules are followed

increased efficiency will be produced in many cases. First comes cleanliness. All apparatus and the operating table should be cleaned often. Do not allow dust to accumulate, or the binding posts or switch contacts to become corroded or dirty. Run all leads as directly as possible and do not allow loose ends to wander at will about the table. It is preferable also to solder a terminal on each wire. Arrange the circuits as far as possible so that the coupling between circuits is confined to the coils designed for this purpose. Very often poor results are obtained as a result of a system of wiring which resembles the freight yards of a railroad terminal. Especially in circuits designed for undamped reception, cleanliness and arrangement of wires plays an important role. A little resistance may make the whole difference between success and failure. Make soldered connection wherever possible. See that all binding posts are kept clean and tight. Keep switches clean and making good contact, and a great many troubles will disappear.

For reception of undamped waves, the condenser values should be relatively small compared with those which would ordinarily be used for spark reception. If an amplifier be used, reversing input leads or tickler leads may make all the difference between success and failure. Correct polarity of both batteries is necessary also, as well as the proper amount of voltage. Less precaution is necessary when using the crystal detector, but when it is considered how small is the amount of energy being handled, it should be realized that too much precaution cannot be taken.

On the transmitter, use leads of sufficient circular mil area to prevent a high impedance and consequent low power factor. It does not avail much to have 1,000 apparent watts flowing and only 0.3 kw. in the transformer. If the transformer is rated at 7,000 volts, do not use a spark gap of such a length that the condenser voltage must rise to 15,000 volts to break it down. If the outfit boasts a motor generator, see that the bearings get clean lubricating oil. It may not seem necessary for two surfaces rubbing against each other at a high speed to have any lubrication, but years ago somebody established the custom of looking at motor generator bearings once in a while to see that they were getting oil. We might as well cater to custom as long as it saves the delay and expense incident to getting new bearings.

The best commutator advice ever printed for the inexperienced is "let it alone." If the temptation to fix it becomes too great to be overcome, however, take the precaution to throw overboard all the cold chisels, files,

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Prize Contest Announcement

Articles submitted to be printed in July issue on the subject.

"A Sensitive and Compact Portable Receiver."

Closing date, May 10, 1920.

Summer, with its vacations and days when one loves to be out of doors, is on its way, and many will begin to plan the construction of apparatus which is sufficiently portable to permit its inclusion in the camp kit, or the holiday trunk. There have been a great many developments since the last holiday season when Government regulations permitted the use of radio apparatus, as a result of which portable devices now in existence will have become, perhaps, more or less obsolete. The portable receiver should, if possible, include a vacuum tube detector. The great objection to the use of this detector in a portable receiver lies, of course, in the necessity for a heavy battery for filament current supply.

In the case of the outfit being taken on a cross-country hike, dry batteries or a low ampere-hour capacity storage cell may be substituted. In the case of the camp outfit where no supply current is available, the crystal detector has to be depended upon, but in the case of one who goes to the sea-shore or to some summer resort, it should either be possible to rent a storage battery from some handy garage or to devise a means whereby the detector tube may be supplied from the lamp socket in one's room.

PRIZE CONTEST CONDITIONS—**Manuscripts on the subject announced above are judged by the Editors of The Wireless Age from the viewpoint of the ingeniousness of the idea presented, its practicability and general utility, originality, and clearness in the description. Literary ability is not needed, but neatness in manuscript and drawing is taken into account. Finished drawings are not required, sketches will do. The contest is open to everybody. The closing date is given in the above announcement. The Wireless Age will award the following prizes: First Prize, $10.00; Second Prize, $5.00; Third Prize, $3.00, *in addition to the regular space rates paid for technical articles.***

All manuscripts should be addressed to the Contest Editor of The Wireless Age

hammers, and sledges at hand before attacking it. Give the unfortunate repair man a chance.

Much may be said about storage batteries and their care, but the main points are: keep the battery clean; watch for acid creeping and corrosion; keep the plates covered with solution. Many operators have discovered that it is easier and quicker to bring the solution up to the proper specific gravity by adding acid than by charging. This is a tremendously clever idea and a great saver of time, but such is the perversity of storage batteries that they persistently refuse to accept this innovation. Wise men prefer the old established methods and keep off this method of raising the "speegee." Do not discharge beyond the point given by the maker, and do not allow the battery to stand idle when low. Place it on charge as soon as possible. Contrary to opinion in some quarters, 100 A.H. stamped on a cell does not mean that it may be left on short circuit for one hundred actual hours!

Too much antenna insulation is a valuable fault in any installation. Too, no one has ever yet succeeded in mak-

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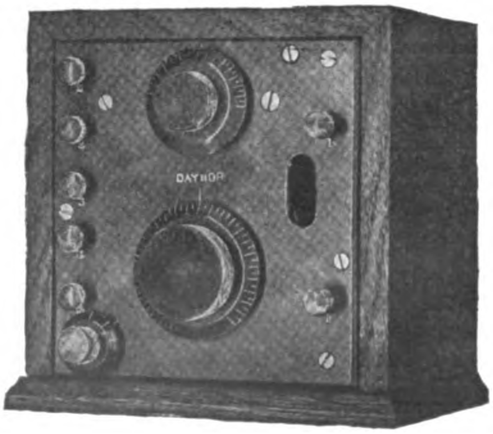

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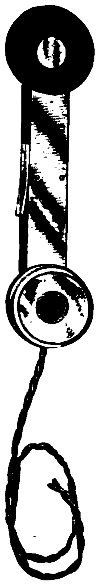

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ing the ground lead too short. Keep the antenna resistance as low as possible. A circuit as stiff as a bar of iron will have difficulty in oscillating even though its intentions are the best in the world.

In the oscillating circuit use strip or tubing if procurable, and, as in the case of the receiver, try and arrange so that all the coupling takes place in the oscillation transformer.

While it is possible that the people who put up the money for wireless equipment may go to the trouble and expense of installing some appliance that they do not intend shall be used by the operator, still in the main, this is not the case, and such scintillating schemes as tying or jamming in a circuit breaker so that it cannot open, or replacing a fuse with an enormous piece of wire, will never set the world of science afire. Innovations of this character, too, are not overwhelmingly popular with the people who have to effect the repairs to the outfit as a result of such blacksmith methods of handling.

While meters will read higher without their shunts and resistances, it is customary to allow these to remain connected to their respective meters, if only because of the mental attitude of the makers that these are essential if the meters are to function properly.

Due to the slow rate of progress made by our inventors and manufacturers, the elastic telephone cord has not yet arrived, and it is better to remove the head set when wandering from room to room. Such cords as we are offered have a disagreeable habit of breaking when we attempt to stretch them more than a yard, and this causes the receiver to function

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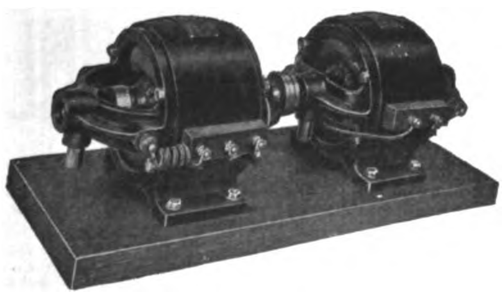

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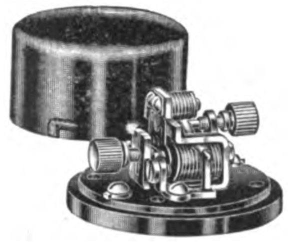

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poorly, due, of course, to the unmentionable detector.

Try to confine sparking to the spark gap. Several sparks operating simultaneously at different parts of the wiring or switchboard are unnecessary. The one furnished with the set is sufficient.

Before proceeding to disembowel your receiver, have a clear idea of what you propose to prove. It does not pay to cut, slash, and short circuit indiscriminately and then be able to re-assemble after the new hook-up has proved a failure. In case this happens, and you give the repair man a chance, admit at once that you have perpetrated improvements. The inside of the box may contain connections fearful and wonderful to behold, but unless he has reason to suspect it has undergone something of an ordeal, he will probably spend considerable time looking elsewhere for the trouble.

A motor generator or transformer name plate marked 1, does not imply that this is the minimum power at which it may be worked; when increasing power, it is better not to wait until the apparatus bursts into flames before deciding that perhaps the allowable increase in temperature is being exceeded. Horsepower is horsepower, much the same as "pigs is pigs," but if your motor, marked for instance, 3 HP, shows a tendency to slow down when you attempt to pile on the load, do not decide at once that the particular three horses that the manufacturer of your motor had in mind must have been emaciated, underfed, and on the point of death.

Of course all this has been written many times before. The only reason we keep on writing the same stuff is that we live in hopes that some of those who know better will come to think there is something to it.

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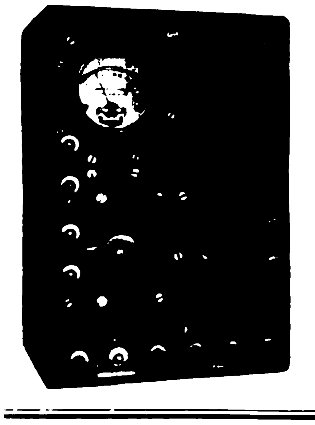

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Albany Radio Club

THE meeting night of the Albany Radio Club has been changed to Monday evenings, instead of every second Tuesday, and hereafter the weekly sessions will be held in the Y. M. C. A. building, Albany New York.

This club has installed a modern receiving set and a number of distant stations have been heard. Temporarily, a six-inch coil is to be used for transmitting, but it is expected that this will be replaced by a transformer in the near future. Other equipment includes a number of buzzer sets which have been installed to help the younger members to master the code.

E. C. Tasolett, president of this club, has a private radiophone set and is giving concerts every Saturday evening which are enjoyed by amateurs within a radius of fifteen to twenty miles.

The members of the Albany Radio Club would like to hear from amateur organizations and a wide-open invitation to this end is extended by Herbert Ammenheuser, corresponding secretary.

Clean English in Wireless

HAS it ever occurred to those operators of radio telephone stations in the vicinity of metropolitan centers and elsewhere that what is being said by them is being heard by hundreds and perhaps thousands of ears?

Has it ever occurred to those experimenting with radiophones that they may be "getting out" when they think they are *not* being heard?

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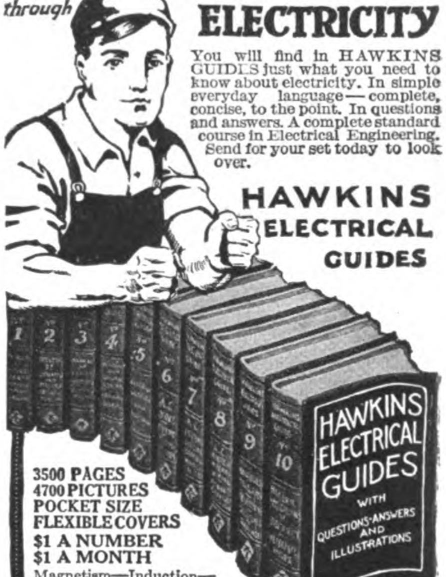

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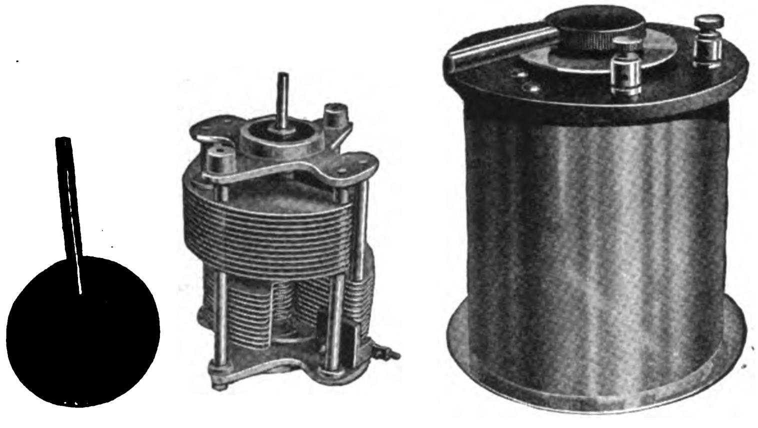

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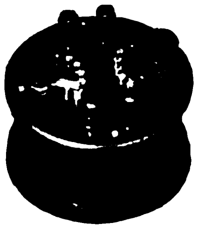

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in the vicinity of New York City on a recent date, when the ether was thoroughly contaminated with foul and profane language.

This wireless game is a great game, and those of us who are interested in it should do all we can to foster interest on the part of others. We can think of nothing which will so quickly kill the game as thoughtlessness in the respect just mentioned. In the old days when all amateur radio was strictly telegraph, we presume that those who were unable to express themselves in *clean* English gave little thought as to *what* they might say, since there was always a feeling that only the initiated few would be able to understand them, but with amateur phones coming into general use, unless we are mistaken, the entire family "sits in" for the evening concert. After reading the above may we suggest the use of a little imagination?

Queries Answered

Answers will be given in this department to questions of subscribers, covering the full range of wireless subjects, but only those which relate to the technical phases of the art and which are of general interest to readers will be published here. The subscriber's name and address must be given in all letters and only one side of the paper written on; where diagrams are necessary they must be on a separate sheet and drawn with India ink. Not more than five questions of one reader can be answered in the same issue. To receive attention these rules must be rigidly observed.
Positively no Questions Answered by Mail.

H. A. T., Brooklyn, N. Y.:

In reply to your several queries; prior to the assignment of WSE to the Sea Gate Station, their call was "SE." Sea Gate abandoned the magnetic detector in 1912. This station rated 3½KW, and used a non-synchronous spark gap.

The call for the Manhattan Beach Station was "DF" (Dreamland, Coney Island). There is no data available as to the date on which the Manhattan Beach Station was opened. A straight gap was used.

The United Wireless Co. was absorbed by the Marconi Company in 1912.

The range of the station at 42 Broadway, New York, "NY," which was shut down in August of 1912, was about 300 to 400 miles day time. It was very common, however, for "NY" to work distances of several thousand miles.

The station at Bush Terminal, Brooklyn, "WCG" has always been owned by the National Electric Signaling Co., now the International Radio Co.

We are uncertain as to when the Cape Hatteras station, "HA," opened up, but it was probably in the fall or winter of 1907. This station was closed April 7, 1917.

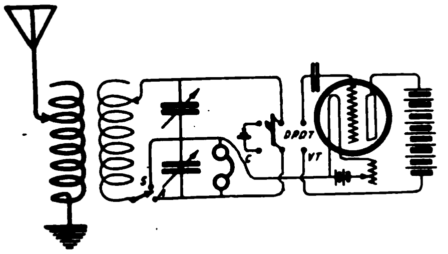
We are unable to say definitely as to when the first time signals were sent out by radio. The regular transmission of time signals in the U. S. commenced, however, directly after the completion of the Arlington station in the late fall of 1912.

At the time when Jack Binns sent out the first "SOS" from the S. S. Republic there were about 400 vessels which carried radio.

The Marconi Service News has been changed to "World Wide Wireless," and we suggest that you communicate with the Radio Corp. of America, Woolworth Bldg., N. Y.

M. K., Oakland, Calif.:

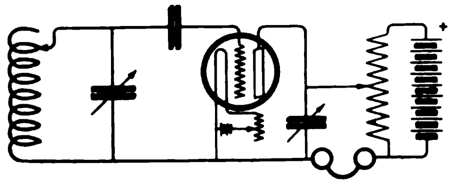
With reference to the circuit diagram on page 34 of the September issue, the reception of arc signals and of spark signals at their natural tone is effected by adjustment of the switch marked "tickler" and the bridging condenser. It is only possible conveniently to switch from spark connection to continuous wave connection when a circuit is used wherein the "back coupling" is capacitive. Such a circuit is shown below, wherein a switch has been incorporated for change from crystal to audion detector.



The 110 volt house lighting current may be used to light the filament of the audion and to supply the plate battery. This scheme cannot be made to operate quietly without considerable difficulty, the 60 cycle hum being heard in the telephones continually. It is needless to point out that this may become quite troublesome in cases where extremely weak signals are to be received.

Iron core amplifier transformers have proven to be the most satisfactory. We hope to be able to publish in the near future an article on how to construct them. The construction of an efficient amplifier transformer is not a very easy problem for the amateur inasmuch as the windings consist of many thousands of turns of No. 44 wire.

It is suggested that you use a switch for the regulation of your B battery in preference to a potentiometer. The battery will last longer since there is a continuous leak through the potentiometer when connected to the battery. A diagram showing connection for potentiometer is given below.



We regret that we have no data available concerning the construction of De Forest Company's radiophone outfit.

* * *

A. E. H., Toronto, Canada:

Asks for information concerning the schedule and wavelengths of radio telephone stations. Perhaps some of the readers of the Wireless Age will be glad to submit any information concerning the wavelength and schedules of radio telephone stations within their receiving range.

There are several amateurs within the vicinity of New York City who are operating radio telephone outfits on wavelengths between 200 and 400 meters. Several of these have been able to communicate with points as far west as Ohio, and if you have an outfit which is particularly efficient on short wavelengths, you should be able to pick these up. In addition to this, the Western Electric Co. has been carrying on experiments with radiophone outfits at wavelengths in the vicinity of 1500 meters. As far as we know, none of the stations mentioned have regular schedules, and in fact, we know of no other stations which do have, inasmuch as all of the work is purely experimental.

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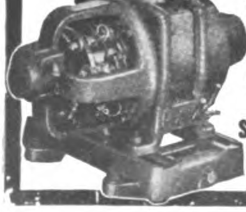

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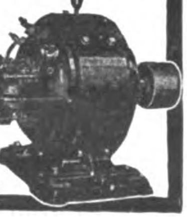
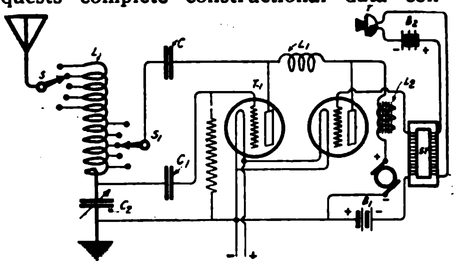


H. R. W., Lansing, Mich.:

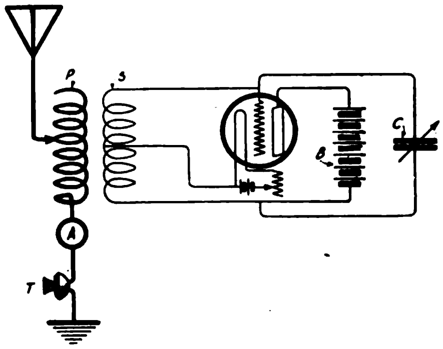
Encloses a circuit diagram of the "SCR 67" which is reproduced herewith, and requests complete constructional data concerning the radio frequency inductance L, its taps, etc.; the condensers and the radio frequency choke coils L1 and L2, as well as the voltage of the generator used in connection with this outfit. Perhaps some of the readers of the WIRELESS AGE will be able to supply this information.



* * *

C. R. L., Winnetka, Ill.:

A diagram suitable for use in connection with the laboratory radiophone described by J. Pignone in the November issue, is printed herewith.



The wavelength range will be over about 200 to 400 meters, and the transmitting range with such a set, using a Marconi vacuum tube and, say, 350 volts on the plate circuit, should be in the neighborhood of 6 to 30 miles depending on the type of receiver used.

* * *

A. V. M., Penn Yan, N. Y.

There is considerable difference between a radio telegraph and radio telephone transmitter as the average amateur thinks of them. For radio telegraphic purposes the alternating current supply which is available in every town of any size may be passed through a transformer, the voltage thus being raised to 15 or 20 times its original value and then utilized to charge a high tension condenser which upon discharging across a suitable spark gap, sets up high frequency oscillations in the discharge circuit. The discharge circuit is so associated with the antenna circuit that oscillations are induced into and radiated by the antenna. With a spark transmitter these oscillations are radiated in groups at group-frequencies depending upon the frequency at which the condenser becomes completely charged and discharged; or, if a rotary spark gap or discharger is used, the frequency of the groups of oscillations will depend upon the number of times the rotating electrodes pass the fixed electrodes. Present day radiophone practice on the other hand, requires a generator capable of supplying oscillations continuously, that is, oscillations which are not radiated in groups. This is accomplished now-a-days by the use of electron discharge devices such as the three element vacuum tube. For the theory and operation of the three element tube, you are referred to "Practical Wireless Telegraphy" by E. E. Bucher, Wireless Press, Inc., N. Y. C.

While there is considerable difference between a radio telegraph and radio telephone transmitter, the same receiver may be used for both.

We regret that we are unable to tell you where you may purchase a steel mast. You need not necessarily use steel, neither is it necessary to use more than one, although the mean height of the antenna will be considerably increased if it is supported by two masts, and you understand, of course, that the higher the antenna the greater the strength of the received signal and the greater the range of the transmitting station. It is possible to construct your own mast from gas pipe or to build yourself a wooden lattice mast. Suggestions along this line are being printed in current issues of this magazine. If you are desirous of doing transmitting at amateur wavelengths, we suggest that you make your masts about 70 ft. high, set them about 125 ft. apart, and take your lead-in from the middle of the horizontal wires. If you wish to use only one mast, we suggest that this be made as nearly 100 ft. as possible, the wires being brought down from the top of the mast to the station so as to form an angle of about 45 degrees with the mast. In the case of the two masts, it makes no particular difference whether they are in an east to west, or north to south line.

* * *

STATEMENT OF THE OWNERSHIP, MANAGEMENT, CIRCULATION, ETC., REQUIRED BY THE ACT OF CONGRESS OF AUGUST 24, 1912.

Of the Wireless Age, published monthly at New York, N. Y., for April 1st, 1920.
County of New York,
State of New York, ss.

Before me, a Notary Public in and for the State and county aforesaid, personally appeared E. J. Nally, who, having been duly sworn according to law, deposes and says that he is the President of the Wireless Press, Inc., Publisher of The Wireless Age, and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management (and if a daily paper, the circulation), etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, embodied in section 443, Postal Laws and Regulations, to wit:

1. That the names and addresses of the publisher, editor, managing editor, and business managers are:
Publisher, Wireless Press, Inc., 68 Broad St., New York, N. Y.
Editor, J. Andrew White, 68 Broad St., New York, N. Y.
Managing Editor, none.
Business Manager, J. D. Conmee, 68 Broad St., New York, N. Y.

2. That the owners are: (Give names and addresses of individual owners, or, if a corporation, give its name and the names and addresses of stockholders owning or holding 1 per cent or more of the total amount of stock.)
Wireless Press, Inc., 68 Broad St., New York City, N. Y.
E. J. Nally (850 shares), 233 Broadway, New York City, N. Y.

3. That the known bondholders, mortgagees, and other security holders owning or holding 1 per cent or more of total amount of bonds, mortgages, or other securities are: (If there are none, so state.)
None.

4. That the two paragraphs next above, giving the names of the owners, stockholders, and security holders, if any, contain not only the list of stockholders and security holders as they appear upon the books of the company, but also, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting, is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner; and this affiant has no reason to believe that any other person, association, or corporation has any interest direct or indirect in the said stock, bonds, or other securities than as so stated by him.

E. J. NALLY,
President.

Sworn to and subscribed before me this 19th day of March, 1920.
(Seal.) M. H. PAYNE.

(My commission expires March 30, 1920.)

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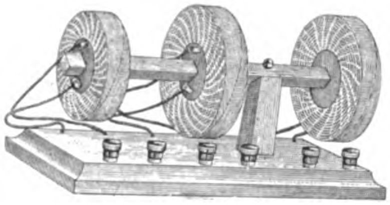

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The Marconi V.T. Patent is Basic

Fleming Pat. No. 803,684
De Forest Pat. Nos. 841,387-879,532

United States Letters Patent to Fleming, No. 803,684, November 7, 1905, has been held to be valid by Judge Mayer of the United States District Court for the Southern District of New York, and by the United States Circuit Court of Appeals for the Second Circuit.

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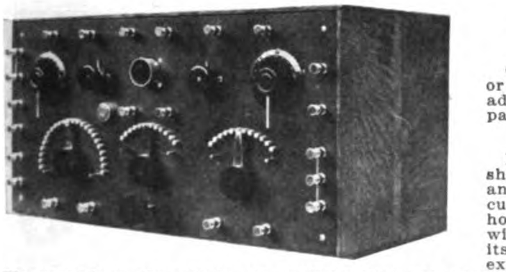

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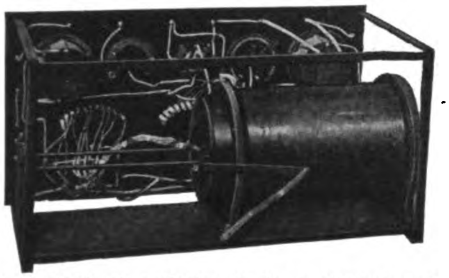

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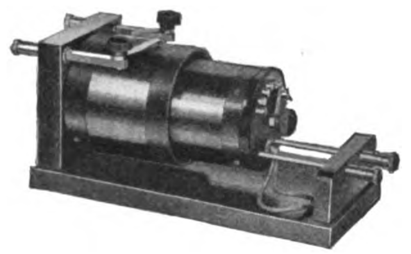

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L-50	240-730	1.52	LL50	1.64	L-500	2340-8500	2.40	LL500	3.35
L-75	330-1030	1.60	LL75	1.70	L-600	2940-12000	2.65	LL600	3.00
L-100	450-1460	1.70	LL100	1.76	L-750	3100-15000	2.80	LL750	3.20
L-150	660-2200	1.80	LL150	2.16	L-1000	5700-19000	3.00	LL1000	3.75
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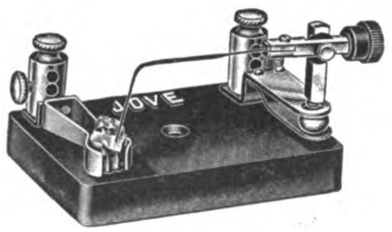

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May, 1920 20 Cents

B1

The WIRELESS AGE

Volume 7 Number 8

Members of Congress Sitting as a Committee on Army Appropriations Get Their Data by Radio 'Phone

Instructing Wireless Students by the Movie Screen

The Design of Multi-Stage Vacuum Tube Receiving Circuits

And a Dozen Exclusive Features in This Issue

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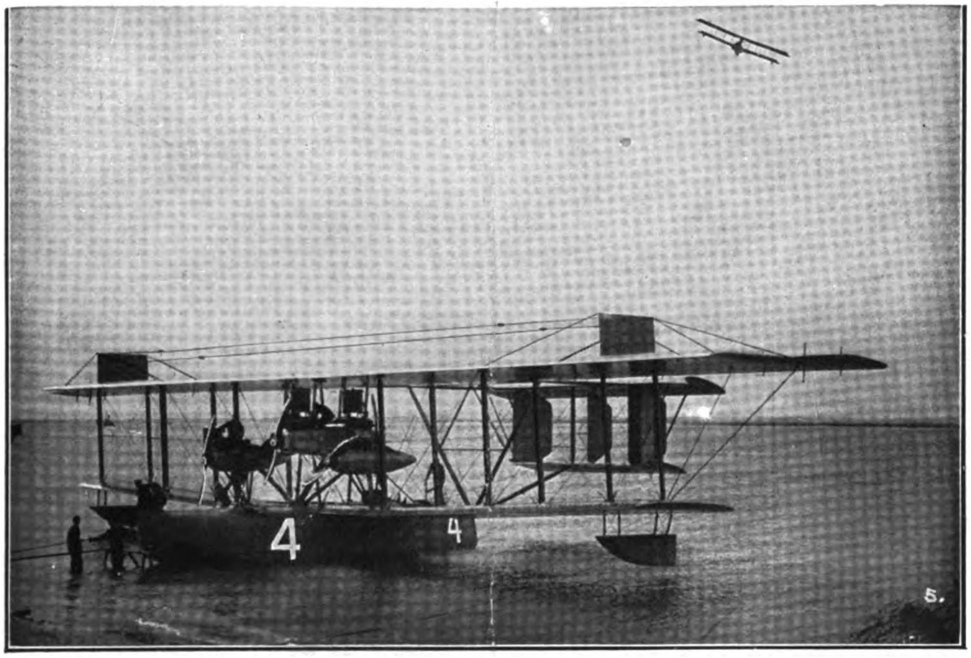
Extract from New York World, June 3, 1919.



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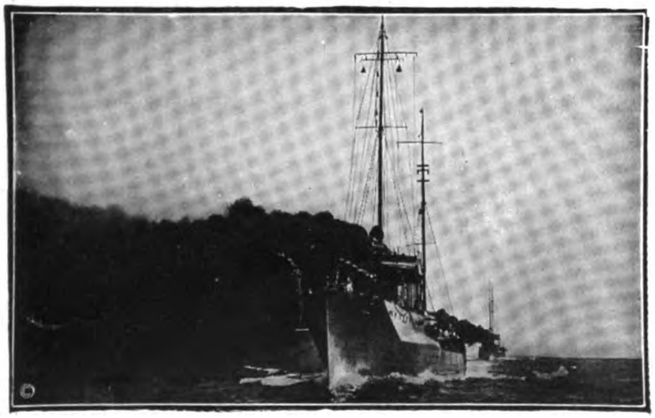

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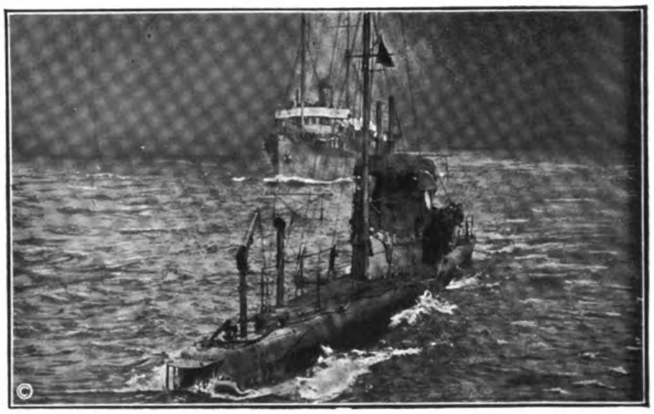

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Edited by J. ANDREW WHITE

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Edward J. Nally, Pres. Lee Lemon, Vice-Pres. David Sarnoff, Secy. George S. De Sousa, Treas J. D. Conmee, Business Mgr.

Owing to the fact that certain statements and expressions of opinion from correspondents and others appearing in these columns from time to time may be found to be the subject of controversy in scientific circles and in the courts, either now or in the future, and to sometimes involve questions of priority of invention and the comparative merits of apparatus employed in wireless signaling, the owners and publishers of this magazine positively and emphatically disclaim any privity or responsibility for any statements of opinion or partisan expressions if such should at any time appear herein.

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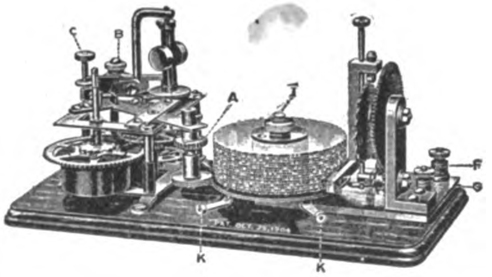

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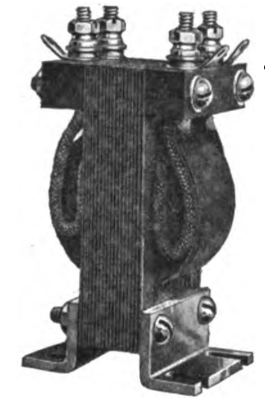

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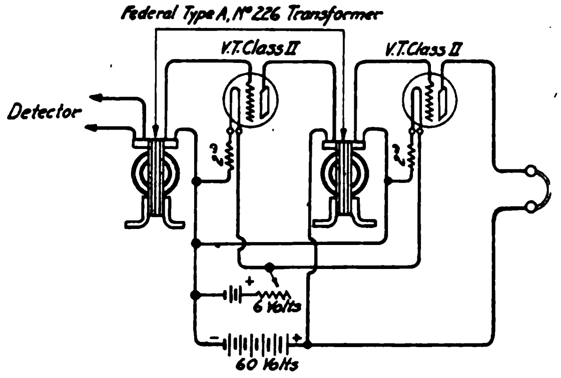

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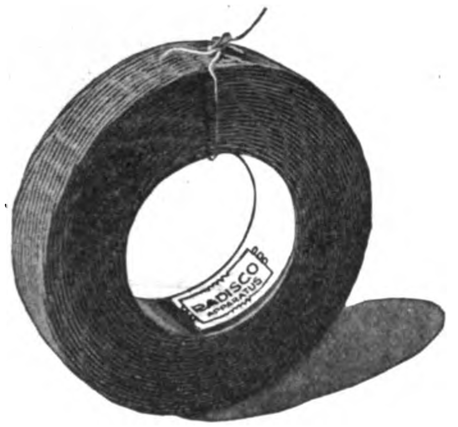

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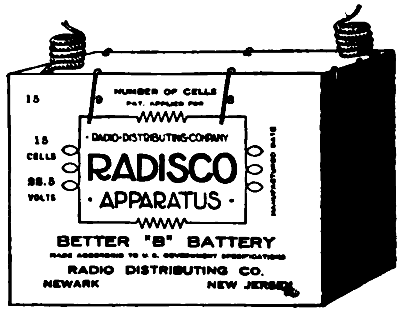

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McKEESPORT, PA.
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427 Olive Street.

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NEWCASTLE, PA.
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Heretofore no effort on our part has been made to put this equipment before the amateurs and experimenters through dealers because our commercial, Government and foreign orders have occupied our constant attention.

We feel, however, that the amateur and experimenter of today is the commercial or Government employee of tomorrow and that it is to his and our benefit that he now become acquainted with the type of apparatus he must eventually use, even though it costs a little more than the typically amateurish apparatus with which the country is flooded.

If you believe as we do and if you are the best, or on a par with the best,dealer in your territory, we have an interesting proposal whereby you may secure the exclusive agency for our equipment.

We recently tried out this idea by giving our exclusive agency for a large Eastern city to a live-wire dealer. The results were immediate and phenomenal. Orders are pouring in and, if we had a few more dealers like him in the principal cities of the country, we feel sure that our amateur and experimental trade would soon rival our commercial and Government business, the same apparatus being sold to both trades.

Are you such a dealer? If so, write us.

Yours very truly,

WIRELESS IMPROVEMENT COMPANY
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47 West Street, New York, U. S. A.

If this page is cut out and appended to the same page cut from the editions to follow, a complete file of very interesting information will soon be available. (No. 5)

Vol. 7. No. 8. MAY, 1920

THE WIRELESS AGE

WORLD WIDE WIRELESS

Marconi Leaves On Testing Trip in Mediterranean

GUGLIELMO MARCONI is working out the details of an invention which will enable wireless stations to tell the exact location of any ship that reports herself in distress. Mr. Marconi has begun a cruise in the Mediterranean to make tests.

Mr. Marconi was asked if he would attempt to communicate with Mars, as was recently reported. He replied:

"No effort will be made to send wireless communications to Mars or receive them. Our vessel will be equipped with sending apparatus having a radius of 3,000 miles only. We are taking two sets for experimental purposes. One is of ½ a kilowatt strength, with a radius of 300 miles for telephone and 500 miles for telegraph. The second is of 3 kilowatts strength, with a radius of 1,000 miles for telephone and 3,000 miles for telegraph.

"I am more interested at this time in practical development of the wireless telephone than vague electrical impulses which may come from wireless apparatus on some other planet. However, the experimental laboratory is keeping in close touch with such phenomena, and when it occurs notes are being taken, in an effort to determine the source and meaning of the wireless waves.

"We hope that soon lighthouses and ships can be equipped with instruments that will enable them to tell precisely the location of any ship at sea that reports herself helpless."

* * *

Radiophone an Aid to Legislation at Washington

A RADIO telephone was used to gather information for members of Congress at Washington when the hearings were held on the Army Appropriation bill before the House Military Affairs Committee. It was the first time on record that the new invention was used for such a purpose.

Whenever a question arose on which the committee desired information Major General Lord, Chief Finance Officer of the Army, was called on the radiophone. Headgear was provided for all members of the committee so they could hear the questions and answers.

* * *

Music by Radiophone From San Francisco to Victoria, B. C.

E. A. HAUGHTON, radio superintendent of the Canadian Government, reports that he was recently working on a long wave length in his wireless station in Victoria, British Columbia, when he heard the following conversation:

"Hello, Point Arguello. This is San Francisco. Wait a moment and I'll play you a record."

Haughton then heard a record of "The Star-Spangled Banner" played.

Radiophone Service Between England and Holland

WIRELESS telephone communication between England and Holland is about to be opened. Results with test calls have been excellent, it is announced, conversations having been carried on up to a distance of 1,200 miles.

* * *

Radio Service for Wanamaker Stores

AFTER being out of operation since April, 1917, the wireless station on the roof of the John Wanamaker store in Philadelphia has been restored and is ready for regular communication with the New York store.

All the hurry-up messages necessary between the two stores will be sent regularly by wireless instead of by telegraph. The antennae for the receiving of messages are 350 feet from the the ground, the poles being 130 feet high from the roof of the building. The wireless equipment installed is largely that which was dismantled at the beginning of the war. Testing or "tuning up" was done under the direction of E. M. Hartley, district manager for the Radio Corporation of America.

* * *

Rogers Honored by Maryland Assembly

DR. J. HARRIS ROGERS, of Hyattsville, Md., developer of underground and underwater radio, has been extended a vote of thanks in a joint resolution unanimously adopted by the Maryland State Assembly. The resolution was introduced in the Senate by Oliver Metzerott and in the House by Clarence Roberts.

* * *

General Electric Company's Radio Report

THE pamphlet report of the General Electric Company for 1919, which has just been issued, contains the following statement by C. A. Coffin, Chairman of the Board:

"Your company has for several years been engaged in its research laboratories and factories in the development and manufacture of apparatus and devices essential to the transmission and reception of wireless communications. Its inventions have had a far-reaching effect on the entire radio art. The Marconi Wireless Telegraph Company of America is also the owner of valuable patents, rights and licenses, and it has seemed wise to the Boards of Directors of both companies that their research and engineering resources should hereafter be used in closest co-operation. To this end, and in order to secure the benefits of the long and varied electrical manufacturing experience of the General Company on the one hand and the operating experience of the Marconi Company on the other, a new company has been formed, known as the Radio Corporation of America, in which both your company and the Marconi Company have accepted a considerable participation."

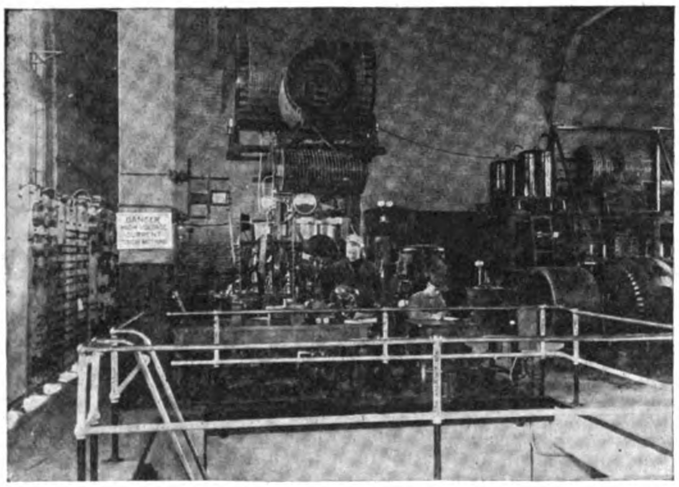
Wireless Operators Needed for Alaska

LIEUT. COL. F. B. SHAW, chief of Army recruiting in Boston, has been urged by the War Department to recruit radio and telegraph operators for the Signal Corps, for service in Alaska. Men accepted in New England will be instructed at Camp Alfred Vail, Little Silver, N. J., and sent to Alaska promptly.

◆

Oriental Radio Rates Reduced

THE Radio Corporation of America announces that the rate for wireless dispatches between San Francisco and Japan were reduced from 80 to 72 cents a word, beginning April 1.



General view of the power room of the Arlington station showing switchboards at left and the 30 kw. arc transmitter at top

Japan Erects Tall Concrete Wireless Masts

THE highest concrete poles in the world (660 feet) are being erected at Tomioka-cho, in Fukushima Prefecture, Japan, for the new wireless stations which will be opened soon, especially for communication between Japan and the United States. One station will receive and the other will send. The capacity each way is about 8,000 words a day.

◆

Vancouver-Victoria, B. C., Radiophone Service Opens

THE Marconi Company of Canada has installed a wireless telephone apparatus at Vancouver, B. C. and at Victoria and will open a service within a few days. The plant has a radius of over 500 miles. It is planned to place stations throughout Canada. The success of the Montreal Rimouski experiment has led to the present development in this branch of utility.

◆

Resumption of Radio Service Pleases San Francisco Business Men

SHIPPING men, operators, exporters and importers announce that the resumption of the wireless service by the Radio Corporation of America will prove an advantage to all concerned and that it will be possible to get messages through between this country and the Far East with the same degree of regularity that obtained before the war. Instead of waiting three weeks for replies, it will be possible to get returns in two and three days at most. This will have a beneficial effect upon all overseas shipping and will stimulate the movement of commerce and the sale of merchandise.

Wireless on Chinese Wall Unite Ancient and Modern Wonders

A REINFORCED concrete wireless mast of large dimensions has been erected upon the Chinese wall for the use of the American navy. It is 164 feet in height. The original program called for the making of the mast by the precast method in two parts, and then erecting them by means of derricks, but an accident occurred while the erection was taking place and an American engineer and four coolies were killed. The method of forming in molds was then tried, and although it was much more expensive than the other, it was successfully carried out.

◆

English Use Wireless for Police in Ireland

IN consequence of the frequency with which telephone and telegraph wires in Ireland are being cut out, the government has decided on an extensive use of wireless telephony there, says the Daily Mail, London.

Naval signal men are being employed to start the system, and the newspaper intimates that portable telephones with a radius of about thirty miles are being employed in transmitting messages from one police station to another or between adjacent towns. It is asserted that the system has proved satisfactory.

◆

Oregon Pilot Commissioners Want Wireless Service

THE Oregon State Board of Pilot Commissioners voted at a meeting to ask the Port of Portland Commission to restore the radio apparatus and service of the bar tug Oneonta. The bar tug's radio set, which was of considerable assistance in receiving reports of vessels in distress off the Oregon coast or reaching the mouth of the Columbia in need of a pilot, was dismantled with the outbreak of the war and has not been replaced.

As the radio station at North Head is operated by the United States navy, all messages received by it are relayed to the Bremerton navy yard before they are placed on a commercial wire, and some complaint has been made that the service thus is not so rapid as it might be. The board of pilot commissioners, acting on this matter, joined the Astoria port commission in asking the navy department that some change be made to facilitate the radio service.

◆

Wireless Withstands Effects of Aurora Borealis in New York

THE Aurora Borealis, or Northern lights, made a brilliant display in the heavens in New York recently and up to 2 o'clock in the morning the wonderful streamers danced, shivered and waved over nearly the whole visible sky. The display appeared more vivid and strong in the north and northwest, but the banners of mystic light repeatedly shot up to the zenith, or uppermost part of the celestial sphere, where they met in an apex or hub.

As usual, the effects of the aurora was promptly felt in the offices of cable, telephone and telegraph companies, communication being seriously interfered with. Wireless service was also affected, but in a less degree.

The aurora, which is seldom visible in New York skies, is a common spectacle in Arctic regions.

Scientists have little to say in explanation of its occurrence, except that it is the result of magnetic activity in the upper region of the earth's atmosphere, these disturbances, in turn, being mysteriously associated with the frequency of sun spots.

Wireless Concert Aboard the Mauretania

W. S. TODD, of Hartford, Conn., who has just returned from a trip to England and Scotland, says that the Steamship Mauretania had a unique experience before leaving Southampton on her last voyage. A wireless message was received by her captain from the Marconi works at Chelmsford, Essex, as follows: "Hear demonstration of wireless telephone from the Marconi works, Chelmsford."

The Cunard Bulletin, issued while the Mauretania was en route for New York, contained the following description of that concert.

"There followed immediately a summary of the day's news and the listeners on board the ship were asked to 'wait a minute.' Suddenly, the voice of a soprano singing 'Land of Hope and Glory' was heard distinctly, followed by a rich baritone who rendered 'The Trumpeter.' A violin solo was clear and resonant, as was the voice of the lady who sang 'There's an Old-Fashioned House in an Old-Fashioned Town.' The little concert closed with the national anthem played on the cornet. Then the call: 'How did you enjoy the concert? The Marconi works are closing for the night but another demonstration will be concluded to-morrow morning at 11:15, Greenwich time. Good night!'

"Although only six ear pieces were used in the cabin on board the ship, it was possible for six other persons to overhear the demonstration distinctly. The voices were almost too loud, but that may have been due to the extreme sensitiveness of the ship's installation.

"At the time the concert was held, the Mauretania was 100 miles away from the works."

◆

Charlestown Navy Yard to Use Radiophone

IN order to expedite conversations between naval ships coming in and going out a wireless telephone has been established at the Charlestown navy yard. It frequently happens that commanding officers of ships desire to talk with the commandant of the yard and they have to resort to the wireless. The telephone will have a speaking radius of 10 miles during the day time.

◆

Destitute Austrian Operators Appeal for Aid

AN appeal to brother wireless operators has been received from the Austrians at the Deutschenburg Station and the following radiogram sent via Lyons, France, to the Ottercliff Station:

> "In sorrowful condition of nourishment in Austria we beg the American wireless operators as commands to help us with Dollapackets. None of us have relations in the United States, but each of us has been very often with the ex-Austrian steamers as wireless operators. The number of members of this wireless station is sixteen. With foremost thanks,
>
> THE WIRELESS OPERATORS OF THE
> AUSTRIAN STATION DEUTSCHENBURG."

This is a humane appeal which many of the wireless operators are going to answer. A substantial fund has already been collected. All readers of THE WIRELESS AGE are invited to help out.

The "Dollapackets" contain a dollar's worth of food—and the Austrian operators need food badly. Further comments are unnecessary.

Let us show them by quick action that the American radio men are really and truly the foremost members of the great fraternity of men who never fail—especially where an S.O.S. call of distress commands their action. This is obviously a call of distress.

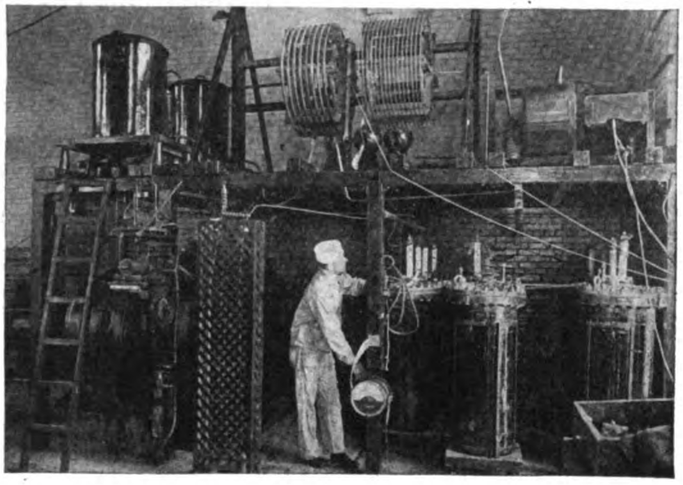
Those who would like to be of some service to the suffering radioists abroad are invited to send their contributions to the "Dollapacket Fund," c/o THE WIRELESS AGE.

Senate Passes Radio Bill

SENATOR POINDEXTER'S bill authorizing the Navy Department to operate certain radio stations for transmission of press and commercial messages was passed by the Senate March 10 without a record vote after it had been amended to provide that private business should not be handled at less than cost.

Senator Phelan, Democrat, California, put into the record a letter from Secretary Daniels urging some such legislation, and one from V. S. McClatchy, of the Sacramento Bee, declaring that provision for transmission of news to the Orient at a low rate would be a powerful factor in promoting good relations with Japan.

The bill expressly provides, Senator Poindexter pointed out, that special low rates be established for press dispatches.



Section of the power room showing 100 kw. spark transmitter of the U. S. naval high power station at Arlington

American Marconi Company Dissolved

STOCKHOLDERS of the Marconi Wireless Telegraph Co. of America at a special meeting held April 6, voted to dissolve the company. This action finally concludes a plan whereby the assets of the Marconi Wireless Telegraph Co. with certain exceptions, are to be taken over by the Radio Corporation of America. Henceforth the business of the company will be conducted under the latter name.

◆

President Wilson's Wireless to Open Air Meet

PRESIDENT WILSON will officially open the third Pan-American Aeronautical Congress on the Steel Pier, Atlantic City, N. J., and at the Airport beginning May 20.

A wireless plant is being installed on the end of the pier, where the flash from the White House will be received at 3 P. M. on the opening day. Wireless greetings also will come from government heads of several South American republics, where aviation now is popular.

◆

Legion's Radio Intelligence Post Making Progress

THE third meeting of the Radio Intelligence Post of the American Legion was held in New York City. Men were present who had traveled many miles to attend, but all agreed that it was worth it.

All former members of the Radio Intelligence Department, either in service abroad or at home, and who wish to get in touch with their former pals are cordially urged to communicate with the acting secretary of the post, Arthur L. Bernhard, 1679 42d Street, Brooklyn, New York.

Visualizing the Unseen

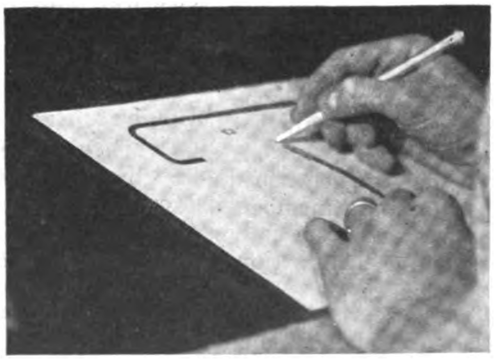
By Jerome Lachenbruch

E. Lyle Goldman, of the Bray studios drawing the background for one of the electrical animated drawings

A FEW hundred feet of film, a motion picture camera and an artist with imagination and ingenuity are solving the intricate problems of electricity for the beginner. The various phases of electricity have been visualized on the motion picture screen so that any one may understand them. The principle of induction, the working of the wireless telegraph and telephone, and many other phases of the subject are now being shown to the general public; also they form part of the curriculum of instruction in many elementary and secondary schools.

Strange as it may seem, the visualization of electrical topics is a direct development of the process by which the animated cartoon is made. A few years ago John R. Bray, a Brooklyn newspaper cartoonist, discovered that by making a series of cartoon drawings and photographing them on a motion picture film, he could produce the appearance of cartoons in motion. In his first attempt he drew about 10,000 individual pictures, worked for about ten months and then saw his arduous work reeled off in about ten minutes. He realized that the work was impractical if done in this way and began to study ways to simplify the method. After several weeks of analytical study, Mr. Bray discovered that many different motions may be represented by the same bodily action. For instance, the delivery of a blow, represented by the arm drawn back, is very similar to the motion executed in throwing a baseball. Consequently, when these two motions are to be shown in the same picture, the drawings are not duplicated. They are simply photographed on the motion picture film in their proper order. Furthermore, it was learned that many motions require only a change in part of the figure, say the arms or the legs. And so a cartoon figure may go through several movements without changing the position of the body. In utilizing this fact, Mr. Bray drew a man's body, then on another sheet of paper his legs, and when the legs changed position he drew them in the new position. By superimposing the second drawing over the first picture of the body, a new complete figure appeared. This eliminated the drawing of thousands of lines and avoided immeasurable duplication in the making of the original drawings. Now, only about 1,500 drawings are necessary to make an animated cartoon.

The original drawings are made on transparent paper and are traced on transparent composition plates which are then photographed by an inverted motion picture camera set up on a rigid frame above a table. An ingenious arrangement of gears and small linked chains carries the control of the motion picture camera to a pedal beneath the photographing table which the photographer operates with his foot. At every pressure of the pedal the shutter opens for a measured length of time. Of course, on the table is a frame to which Cooper Hewitt lights are fastened.



Close-up showing the background of an animated technical drawing

Every drawing is numbered and when each is photographed a little indicator, similar to a speedometer in its action, records the number of drawings that have been thus far photographed. The developing and printing of the negative follows the same process undergone by films taken from living figures.

The accompanying photographic diagrams give an idea of the method by which the animated technical drawings are made. Figure 1 shows a battery, upon which is mounted an iron core wound with two coils of wire of different thicknesses. It will be observed that the heavier wire has fewer turns than the finer coil.

The action indicated is an excerpt from the way in which the principle of induction is taught by the "movies." When the connection is made at A, the current flows through the heavy wire, or, technically, the primary winding. In showing this on the screen, figure 1, which is a drawing made on a dark grey cardboard and used as a background for the succeeding pictures, is photographed first.

The phenomenon resulting from the closing of the circuit is twofold. First, a current is set up in the primary winding; secondly, a magnetic field is built up about the core. This fact is conveyed in a title, and is followed on the screen by figure 2, showing the current passing through the primary, then figure 3, showing a magnetic field and the apparent "flow" of the magnetic lines of force. Here the relationship between magnetism and electricity is explained. In the diagram, the lines of force are shown to "flow" all about the core; and the direction of the course of the magnetic lines from north to south through the air is indicated by moving arrows. In conveying this to the screen, the artist who made the drawings made several similar drawings showing the arrows in slightly different positions. When these were photographed on the motion picture film the effect was similar to the flickering which we are all familiar with, securing an effect on the screen of the constant activity of the electro-magnetic field. The diagram of the electro-magnetic field is a photograph of the original background with two transparent plates superimposed upon it.

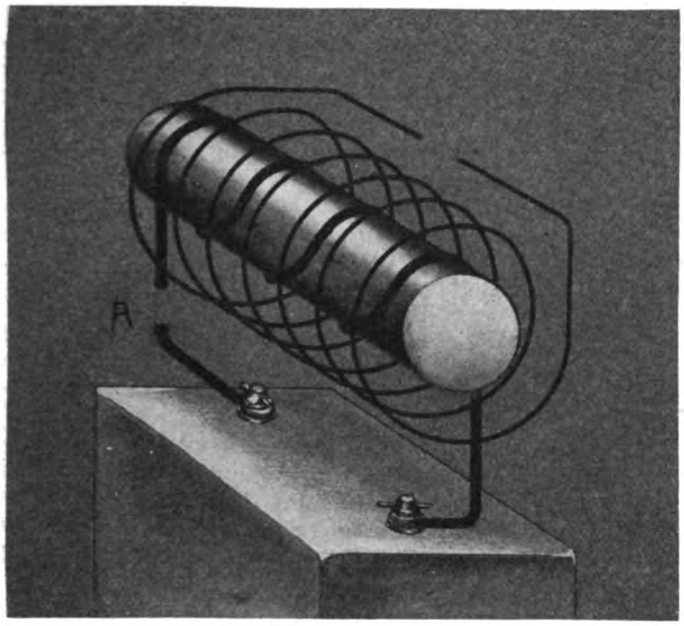


Figure 1—Iron core wound with two sizes of wire mounted upon a battery

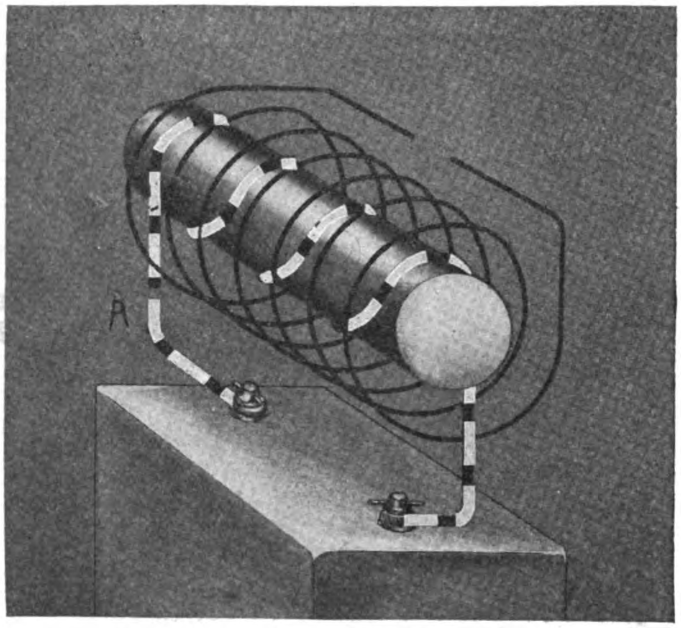


Figure 2—The battery or primary current passing through the primary coil

In following the electrical action further, the contact at A is broken and the electro-magnetic field immediately collapses. What happens now is told in another title that explains, in a few words, the principle of induced currents. The building up and breaking down of magnetic fields constantly results in currents being induced from the primary winding to the secondary. In the motion picture portraying this phenomenon, the current is seen now in the coil of fine wire, the secondary winding. Figure 4 shows this clearly.

It is an electrical fact that a current induced as shown in the figure has its voltage increased and its amperage reduced. This is a principle that has made wireless telegraphy possible, because it permits of the creation of high frequency currents.

But to return to our diagram. The voltage in the secondary is now much greater than it was in the primary winding. This is proved by the fact that it has a potential, or electrical, pressure sufficiently great to enable it to jump the gap and make a completed circuit. The gap, of course, is a familiar contrivance in wireless hook-ups. And here, in the animated technical drawing, its fundamental uses are explained.

Another most important elementary principle of electricity elucidated by the animated technical drawing is the action of the condenser as used in connection with a circuit breaker. This is of particular interest to the student of wireless telegraphy, for the condenser is a storehouse of electrical energy, and in the wireless set is indispensable. The circuit breaker acts as a danger signal by flying open and breaking the flow of the current in case anything goes wrong in the circuit.

To apply the action of the condenser to the screen, the flow of the current in an electrical circuit is shown by means of a series of individual drawings, each differing very slightly from the other. This produces the effect of movement. As a background, a fundamental diagram of a condenser is shown connected with a circuit breaker. The circuit breaker is not drawn on the background, but is a cardboard cutout attached to the background by pins. The various positions of the circuit breaker in opening the line are obtained by moving the dummy by hand and

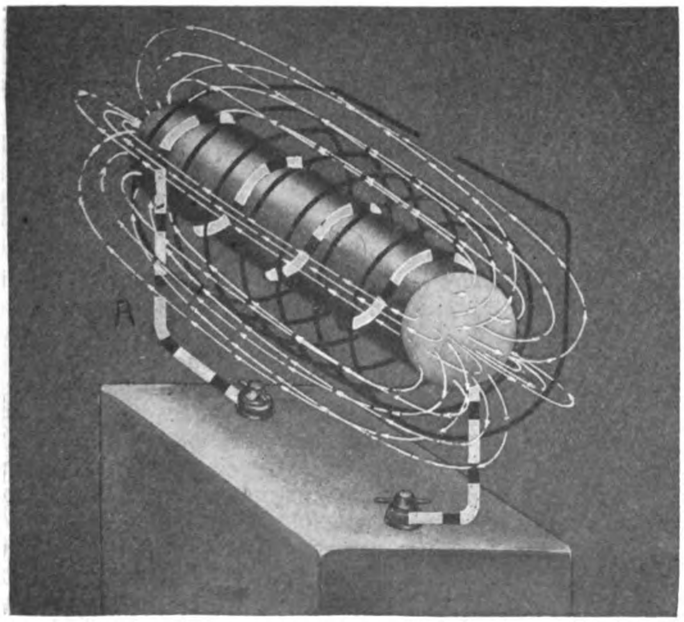


Figure 3—The magnetic field produced by the flow of primary current

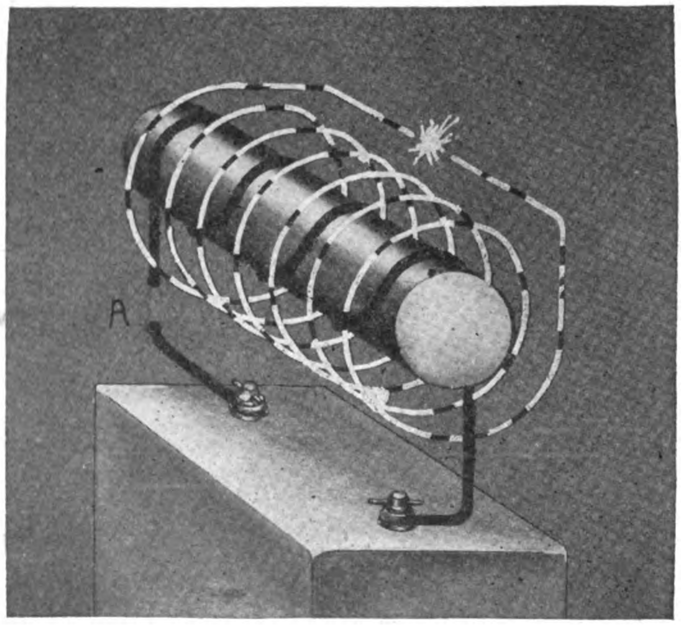


Figure 4—Primary broken at A and induced current in secondary jumping the spark gap

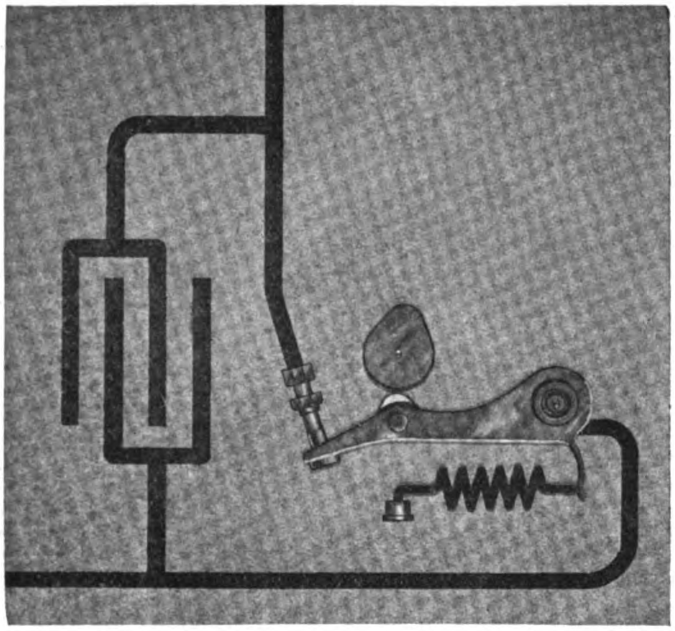


Figure 5—Electrical circuit with circuit breaker and condenser connected

photographing it during the different stages of its action.

The circuit breaker is shown to operate by means of a spring; but to represent the spring in the act of springing many individual drawings of the spring had to be made, otherwise the action as shown on the screen would appear as a jerk. In order to obtain smoothness, the various parts of the diagram that are supposed to move must be drawn in their different positions while the circuit is breaking, and each drawing then photographed on the motion picture film.

Let us assume that the current is running smoothly through the line. In this arrangement the circuit breaker is closed. The dashes in the photographic diagram suggest the course of the current flow. It will be seen that the condenser is not in use, and the point of the cam, which operates the circuit breaker, is turned upward. To obtain this effect on the screen, three drawings were necessary. The first was a background showing the dummy circuit breaker and the general outline of the electrical circuit, together with the condenser. Then a drawing of the spring was made, traced on a transparent composition plate and laid on top of the background, with the result shown in figure 5. Finally, the dashes representing the current were drawn, and the three photographed together, the completed picture being shown in the diagram, figure 6. Now, to make the lesson move on the screen, the plate showing the spring when the circuit breaker is closed is removed as well as the plate indicating the course of the electric current.

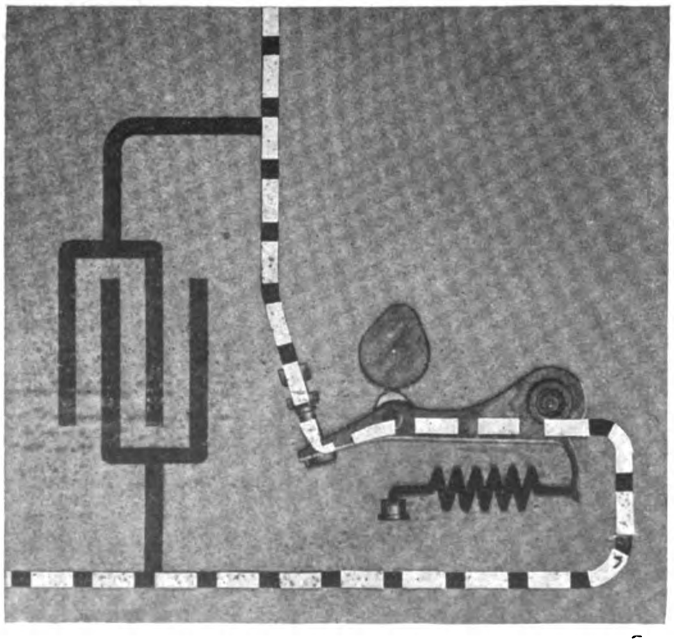


Figure 6—Circuit breaker closed, permitting flow of current

For the next series of drawings, the same background is used. But instead of the first drawing of a spring, another, in a slightly different state of tension, is drawn and placed over the background. Then the cam of the dummy circuit breaker is moved by hand, so that the breaker opens the line and the current flow is seen to be interrupted. See figure 7. Here a title is inserted to state that when the line is open the current flows into the condenser. In order to show this, another drawing of dashes is made to fit over the condenser drawing of the background. What would happen if the line opened and there was no condenser to catch the surplus current is shown by a spark jumping across the opened circuit. This involves several other drawings.

This elementary electrical instruction is invaluable in the teaching of wireless telegraphy. From such fundamentals, the Bray Studios have progressed to the point of teaching how the wireless telegraph operates. For example, most students who are interested in this phase of electricity know that electro-magnetic waves radiate in all directions, yet follow the general course of the earth's surface. Now, the best way to teach an unknown thing is to compare it to a known one and then to show in what particulars the new fact to be taught differs from the thing known. So, in animating the principle of wireless telegraphy, the movie artists have gone back to two known facts: one, the electric bell and the action of sound waves; and two, the ripples on the surface of a lake made by a stone being thrown into the water. This natural phenomenon is understood by everybody; so the comparison between the ever-widening circles on the surface of the water and the electric-magnetic waves of the wireless brings the general principle to the understanding of the masses. Coming closer to the subject, the electric bell comparison tells a similar story, but adds to it by showing that sound waves act like water ripples and also like electro-magnetic waves. In visualizing this, an electric bell in the act of striking is seen to send off waves in ever-widening concentric circles.

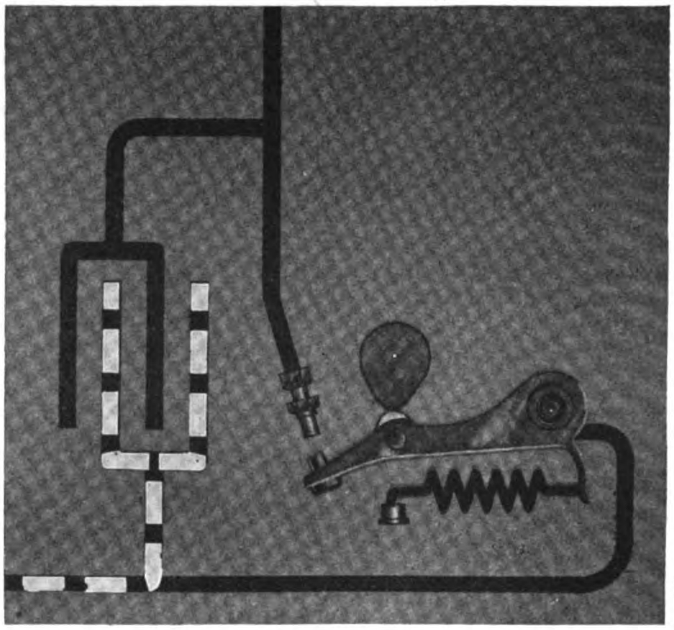


Figure 7—Circuit breaker open and interrupted current flowing into the condenser

But to amplify on the examples, the difference between sound and electro-magnetic waves must be emphasized. This is done by showing a boy shouting, and flashing the fact, in a title, that his voice carries only about a quarter of a mile under the best conditions. The sound waves emanating from his mouth are represented in the form of very short waves. Now the far greater length of the electro-magnetic wave is shown in animated form, and the fact stated that these waves are carried by the ether for thousands of miles. When the possibility of transporting electro-magnetic waves has been established, the construction of various pieces of apparatus is taken up in detail.

The generation of high frequency currents, and their oscillation in the closed circuit until they jump the gap (see figure 4) and pass into the ether; the apprehending of the electro-magnetic waves by the antennae of some receiving station many miles away, and the passing of the current through the receiving set; and finally the "ironing out" or reduction of the current to audible frequency are all shown in a graphic manner.

In all subjects relating to electricity, the screen offers teaching opportunities scarcely realized at present. In the naval wireless school, the schools for general electricians, and for instruction aboard ship, not to mention the many private institutions for the teaching of electrical subjects, the animated technical drawing offers a new way to impart the intricacies of the subjects in an intensely entertaining and practical way.

The Design of Multi-Stage Vacuum Tube Receiving Circuits

By John Scott-Taggart

(*Continued from the December,* 1919, *issue*)

WE NOW come to the usual aperiodic air-core oscillation transformers as a means of coupling the output circuit of a vacuum tube to the input circuit of the succeeding tube.

A two-tube receiving circuit employing this method of coupling is shown in figure 3. An aperiodic inductance coil L_3 is included in the plate circuit of the first tube, a second aperiodic inductance L_4 being placed across grid and filament of the second tube. A leaky grid condenser is included in the grid circuit of the second tube for the purpose of rectifying the high frequency current and producing audible signals in the telephones T. The two inductances L_3 and L_4 may very conveniently be wound together at the same time, or if desired, one of the inductances may be wound directly over the other. This type of amplifier will respond over a wide range of wave lengths, which range may be greatly increased by using resistance wire in place of ordinary copper wire for the inductances L_3 and L_4. The value of the resistance may be made as high as about 20,000 ohms. Obviously, a certain loss in efficiency is unavoidable, but this disadvantage is outweighed by the greater usefulness of the amplifier.

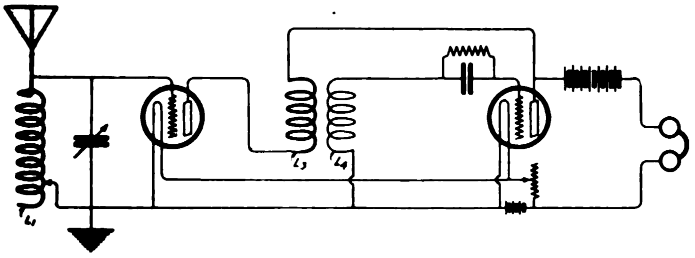
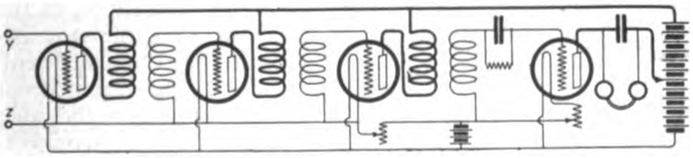


Figure 3—Two-tube receiving circuit coupling the output circuit of one to the input circuit of the other



Figue 4—Four-tube amplifier-detector for oscillatory circuit

Figure 4 shows a 4-tube amplifier-detector which may be applied to any oscillatory circuit for the purpose of receiving wireless signals. As will be seen, the arrangement is merely an elaboration of the circuit of figure 3, the coupling between the tubes taking the form of aperiodic air-core transformers. The terminals YZ are connected across the oscillatory circuit, in which the received oscillations are taking place.

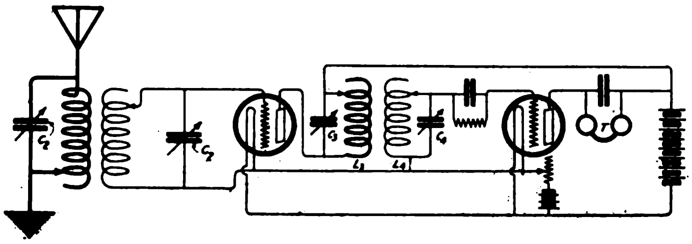


Figure 5—Two-tube receiving circuit which permits very fine tuning

An improved arrangement would consist in tuning the grid circuits of the various vacuum tubes in the series. This arrangement somewhat increases the efficiency of the amplifier and also improves its selectivity. The number of adjustments required, however, make the circuits somewhat unwieldy. It will be realized that a certain step-up effect is obtainable by arranging that the inductances of the plate circuits will have fewer turns than the inductances of the grid circuits. If the grid circuits be tuned, it may be an advantage to have the coupling between the plate and grid oscillatory circuits variable in order to increase the selectivity. If, however, we are aiming to produce a highly efficient circuit which is exceedingly selective, it will be preferable to tune both the plate and grid circuits by means of variable condensers. Figure 5 shows a useful 2-tube receiving circuit which is capable of giving excellent signals and at the same time

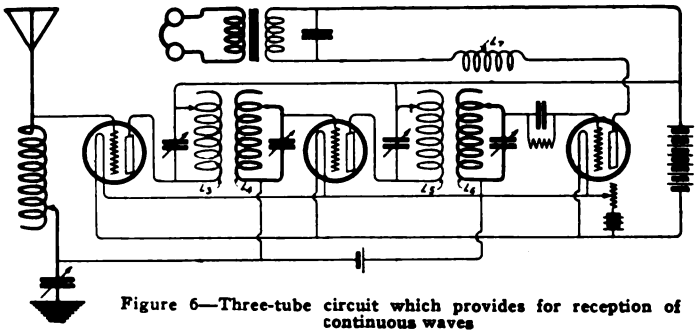


Figure 6—Three-tube circuit which provides for reception of continuous waves

very fine tuning. All circuits are now accurately tuned to the incoming frequency and the degree of selectivity may be varied by altering the coupling between L_3 and L_4. The second tube of this circuit acts as detector, the signals being obtained in the telephones T. Figure 6 shows a 3-tube receiving circuit which is a development of the 2-tube circuit, and which also provides for the reception of continuous waves. In the plate circuit of the last tube is included an aperiodic coil L_7 which may be coupled to any of the foregoing inductances in order to amplify spark signals on the regenerative principle or to produce self-oscillation, and so enable us to receive continuous waves. This class of circuit is especially useful when it is desired to receive within a fairly narrow range of wave length, or on a definite fixed wave length. As a general statement, in amplifiers utilizing air-core transformers an aperiodic coil for producing regeneration may always be placed in the plate circuit of one or other of the tubes and coupled to one of the circuits of a previous tube. If grid current rectification in the last tube is being used, self-oscillation may be produced by the use of an oscillator coil. If, however, the last tube is made to operate as a detector by utilizing one of the bends on the plate current curve, it is not possible to produce self-oscillation. If this form of detection is employed and we desire to produce self-oscillation, an oscillator coil may conveniently be included in the plate circuit of the vacuum tube next to the last. It is to be noted that a condenser of about 0.001 mfd. is invariably connected across the telephones. This condenser, among other things, allows self-oscillation to take place more readily. Incidentally, when a suitable number of tubes are used for amplifying high frequency oscillations, the radio-frequency component in the plate circuit of the detecting tube may be very considerably increased and is liable to cause arcing in the telephone windings, unless a shunt condenser is provided.

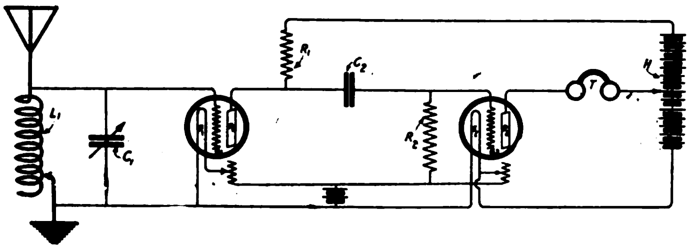


Figure 7—A simple resistance-coupled circuit

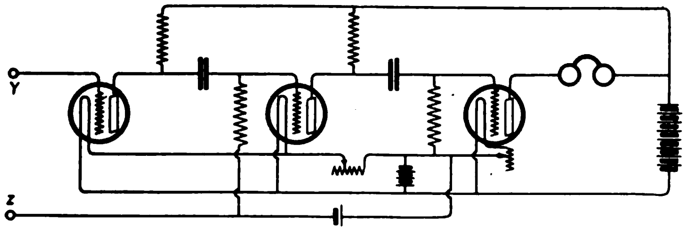


Figure 8—Three-tube resistance-coupled amplifier suitable for general reception

Except for special purposes, it will not usually be desirable to employ more than 3 tubes with tuned inter-tube transformers. The circuits become expensive and difficult to adjust, although this latter disadvantage may be largely overcome by employing a switch which changes the values of the inductances L_3, L_4, L_5, L_6, simultaneously.

We now come to the use of coupling resistances in vacuum tube amplifiers. This class of coupling is aperiodic, and after a certain wave length, is usually efficient for all wave lengths. A simple resistance coupled circuit is shown in figure 7, where two vacuum tubes are shown in use. The first one acts as a high frequency amplifier and the second one as a detector. The resistance R_1 has a value of about 80,000 ohms, and should have neither capacity nor inductance. It may be constructed by cutting two or three parallel grooves 2" long on a sheet of ebonite and rubbing the point of a lead pencil across them. Suitable terminal connections are made at the ends of the conducting grooves. A more suitable type of resistance may be constructed by using strips of paper on which heavy India ink lines have been ruled. Various commercial types of resistances have been placed on the market. Care should be taken to see that the terminal connections do not form a small condenser in parallel with the resistances.

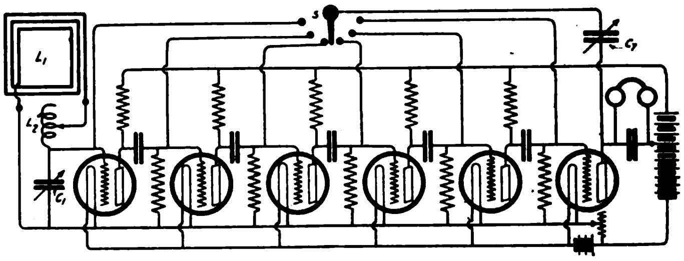


Figure 9—Six-tube amplifier for use with a frame aerial

A condenser C_2 of about 0.0003 mfd. which is connected between the foot of R_1 and the grid G_2 of the second vacuum tube insulates G_2 from the battery H, which would otherwise give the grid a very high potential. When the grid G_1 of the first tube becomes positive, the electron current through R_1 increases; consequently, a momentary negative pulse is communicated through C_2 to the grid G_2 of the second tube. Similarly, when G_1 is made negative, the electron current through R_1 is decreased and a positive pulse is impressed on G_2. In this manner the high frequency potentials across R_1 are passed on the second tube, which rectifies the radio frequency EMFs. Owing to the drop in potential across R_1 the plate battery H will have to be of considerably greater voltage than is the case in an ordinary amplifier. The value of H may conveniently be from 70 to 100 volts. Each tube is shown as having a separate rheostat of about 10 ohms resistance. These rheostats may frequently be dispensed with. Such minor variations in the circuits given here are left to the experimenter. To prevent excessive negative charges building up on the grid G_2 of the second vacuum tube a leak R_2 of about 3 megohms resistance may be connected directly across grid and filament. In place of the telephones T a step-down transformer may be used. A high resistance winding may be included in the plate circuit and a low resistance winding connected across a pair of low resistance telephones. This applies to all tube circuits and the use of such a transformer possesses considerable advantage.

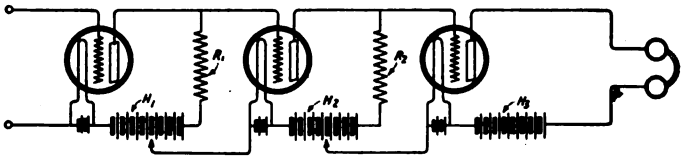


Figure 10—Marconi resistance amplifier circuit containing three tubes

Figure 8 shows a three-tube resistance coupled amplifier suitable for general reception. This circuit is simply an elaboration of the previous circuit and no comment is necessary. The values of the resistances are the same as before. The terminals YZ are connected across the oscillatory circuit in which the incoming oscillations are flowing. The important point to notice in connection with resistance coupled amplifiers is that they are not suitable for reception of short wave lengths. This is due largely to the capacity effect, which is invariably in parallel with the plate circuit resistances. This capacity effect may be chiefly due to the capacity of the electrodes in the tube and is also due to the capacity of leads and connections. This capacity acts as a resistance, or rather, reactance, in parallel with the resistances R. Since the condenser acts as a detector towards oscillatory current, the higher the wave length received, the greater will be its frequency and the more readily will the unintended shunt capacity act as a by-path to the oscillations, and so reduce the impedance of the resistances R. The resistance amplifier is consequently most useful for wave lengths exceeding 1,000 meters. In any case, every precaution should be taken to avoid capacity effects in resistance amplifiers.

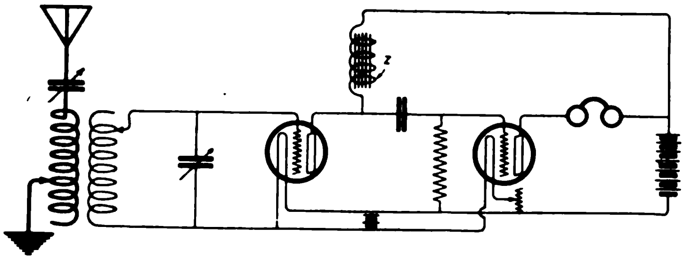


Figure 11—Two-tube impedance circuit for short waves

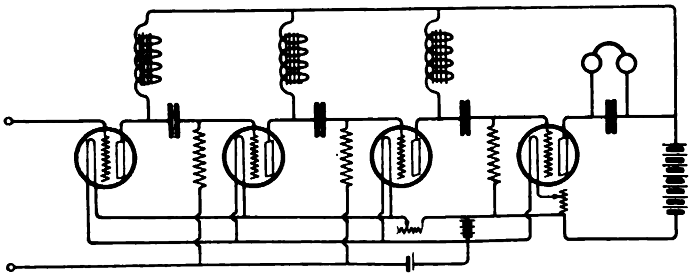


Figure 12—Four-stage amplifier for short waves

Figure 9 shows a 6-tube amplifier being used to receive signals picked up on a frame aerial L_1, which consists of a number of turns of insulated wire on a large frame several feet square. The loading inductance L_2 and the condenser C_1 is for tuning purposes. The amplifier calls for no special comment except that a small condenser C_7 is used for obtaining regenerative amplification. By means of a switch S this condenser may be connected across the plate of the last tube and the grid of another of the preceding tubes. This condenser should have a very small capacity. By gradually increasing this capacity the circuits may be made to pass through the various stages prior to self-oscillation, thus enabling us to obtain regenerative amplification of spark signals, or to receive continuous waves.

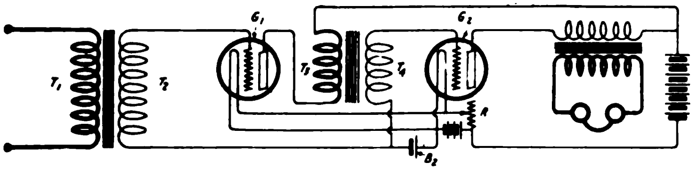


Figure 13—A simple two-stage low frequency amplifier using a step-up transformer

In a resistance amplifier, the grids are alternately positive and negative at any given moment. For example, if the first grid is positive, the first plate will be negative, the second grid negative, the second plate positive, the third grid positive, the third plate negative, and so on. To obtain regeneration, the condenser C_7 should be connected across two electrodes of similar sign. Regenerative amplification may be obtained not only by coupling the plate of the last tube to the grid of the first, but by making suitable connections between any of the intermediate tubes. The condition for regenerative amplification is that when the potential of the plate increases, the grid of the preceding tube chosen should also increase, and vice versa. If the condenser is now connected across the plate and grid, regeneration is obtained and if the condenser is of sufficient capacity self-oscillation is set up.

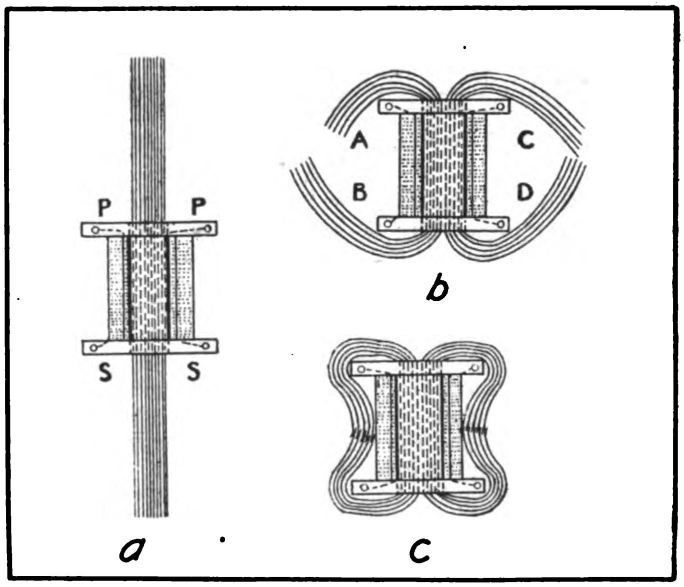


Figure 14—Detailed construction of a transformer

For example, regeneration may be obtained by connecting the last plate to the first grid of an amplifier possessing 2, 4, 6 or, in short, an even number of tubes. If an odd number of tubes were used, absorption—the opposite to amplification—would take place, and the greater the capacity, the less would be the amplification and the less the tendency to oscillate. We can see that regenerative oscillation is obtained when the coupling condenser connects the plate and grid of tubes adjacent to each other, or separated by an even number of tubes. Obviously, the greater the number of tubes in between, the more critical is the adjustment of the coupling condenser, which thus requires to be of very small dimensions. Owing to the difficulty of insuring regular working, it is desirable to arrange the coupling between the plate of one tube and the plate of a previous tube in the series. Rectification is now weak and allows of a more gradual adjustment. The coupling condenser should now be connected across any two plates which are undergoing potential changes of the same sign as, for example, 1st and 3rd, 3rd and 5th, 1st and 7th, and so on. Instead of using a condenser, a high resistance of the order of about 10 megohms may be connected across the plate of one tube and the grid of a

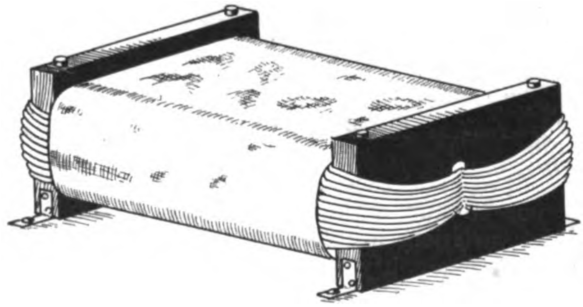


Figure 15—The completed amplifier transformer

previous tube, or the plate of one tube and the plate of another. These general remarks will explain the conditions under which regeneration is obtainable in a resistance amplifier. The present regeneration is obtainable in a resistance amplifier.

However, the writer is not inclined to recommend the use of methods for obtaining self-oscillation in an amplifier, although regeneration is frequently desirable. It will almost invariably be preferable to use an external heterodyning oscillator when it is desired to receive continuous waves.

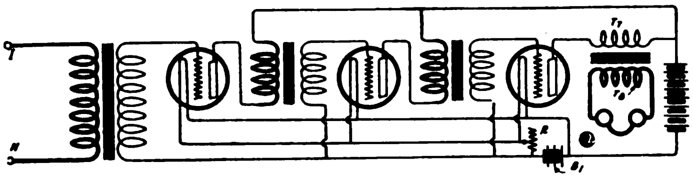


Figure 16—Three-tube low frequency amplifier circuit

An interesting resistance amplifier has been patented by the Marconi Company, which is illustrated in figure 10. In the plate circuit of the first tube is included a high resistance R_1 and a plate battery H_1. If connections were taken from the ends of R_1 across the grid and filament of the second Marconi tube there would normally be a negative potential on the grid of the second tube. This potential would be equal to half the emf. of H_1, if the resistance R_1 equalled the internal resistance of the tube between filament and plate.

It is to be noted that it is usually desirable to make the plate circuit resistance equal to the internal resistance of the tube. To overcome the potential drop across the high resistance in the plate circuit, we have seen that usually a stopping condenser has been used. The Marconi circuit, however, achieves the same object by taking the connections from the top of R_1 and the mid-way point along H_1. It will be seen that the emf. across R_1 is balanced by half the emf. of H_1 acting in the opposite direction. If R_1 does not equal the internal resistance of the tube a suitable point is readily found on H_1 so that the potential difference between that point and the top end of R_1 is zero. When a varying potential is placed on the grid of the first tube, the potential across R_1 also varies whereas the potential across the half of H_1 involved does not vary, at least, not to any appreciable extent. The magnified potential variations are consequently applied to the grid of the second amplifying tube, and the same process is repeated in the case of the second tube, the magnified variations in R_2 being applied across the grid and filament of the third vacuum tube. This last tube may, if desired, be arranged to act as a detector.

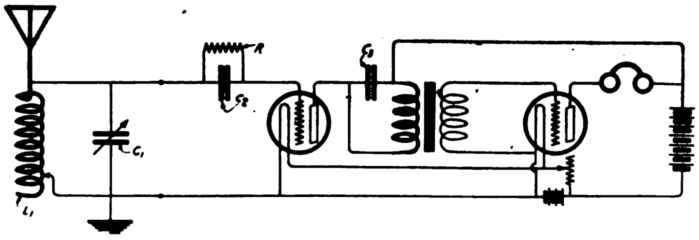


Figure 17—Two-tube detector amplifier circuit in which the first tube acts as a detector

This circuit requires separate plate batteries and filament accumulators. Moreover, it will be seen that any low frequency variations of plate current in the first tube will be passed on throughout the series; consequently, any undesired current variations such as those due to variations in filament temperature or leakage in the circuits are liable to be magnified by the amplifier and produce undesirable noises. In the case of those amplifiers in which stopping condensers are used, these condensers, if of small enough capacity, will only pass on high frequency current variations, and will filter out any audio-frequency effects. The Marconi circuit, however, is capable of being used as an amplifier of steady, maintained, direct current potentials, whereas the other type of amplifier is unsuitable. The principle of taking a tapping from the plate battery to avoid the potential drop across the plate circuit resistance is one of considerable value and may be applied in many vacuum tube circuits with advantage.

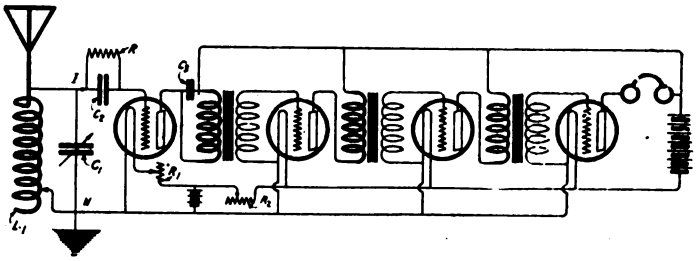


Figure 18—Four-tube detector-amplifier circuit with three tubes for amplification

We have seen that owing to the capacity of the vacuum tube and various strong capacity effects in a *resistance* coupled amplifier, the arrangement is not suitable for the efficient reception of waves less than about 1,000 meters. For the higher wave lengths we can use an impedance coil in place of a high resistance. The impedance offered by such a coil increases with the frequency of the oscillations. It will thus be seen that an amplifier employing impedances will be very efficient for the reception of short waves. Wave lengths as small as 100 meters may be very effectively received on an amplifier of the type shown in figure 11. Two vacuum tubes are here shown in use, the first one acting as a high frequency amplifier and the second one as a detector. The impedance coil Z may conveniently consist of about 10,000 turns of No. 40 silk covered wire, wound on an iron wire core 2½" x ½". An elaboration of this simple circuit is shown in figure 12, which illustrates a 4-stage amplifier which may be applied to any oscillatory circuit receiving short waves. As in the case of resistance amplifiers, regenerative amplification may be obtained by connecting a high resistance of about 12 megohms, or a very small condenser across the plate of the last tube and the grid of say the first tube.

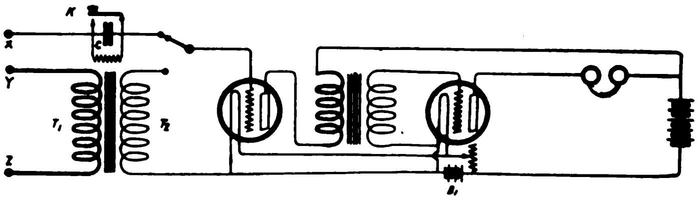


Figure 19—Circuit for use as low frequency amplifier or receiver

Obviously, in a tube of this nature, we can obtain regenerative amplification or self-oscillations by connecting an aperiodic oscillatory circuit consisting of an inductance in the plate circuit of the last tube and coupling this coil to the input oscillatory circuit. In this class of amplifier and also in any other type in which an impedance, such as a telephone transformer winding, is included in the plate circuit of the last tube, the oscillatory regenerative circuit may be connected in *parallel* with the impedance. In this case, one end of the coil is connected to one end of the impedance, while the other end of the coil is connected through a fixed or, if desired, variable condenser to the other end of the impedance.

We now come to the design of amplifiers employing several vacuum tubes coupled by means of iron-core transformers. Of these the most important are probably those employing transformers having primary and secondary, the primary being included in the output circuit of one tube and the secondary in the input circuit of the following tube. A simple two-stage low frequency amplifier is illustrated in figure 13, in which an initial step-up transformer T_1 T_2 is provided. This step-up ratio may conveniently be 1 to 5. The winding T_1 should have a resistance approximating to the resistance of the circuit to which the amplifier is to be applied. In nearly all cases, the winding T_1 will be included in the plate circuit of a tube being used as a detector, consequently the resistance of T_1 should be fairly high. In most British commercial amplifiers the winding T_1 has a resistance of from 300 to 2,000 ohms, or even more. Suitable windings for an initial transformer for general work are: primary—44 gauge single silk covered copper wire, 300 ft.; secondary—44 gauge single silk covered copper wire, 3,000 ft.

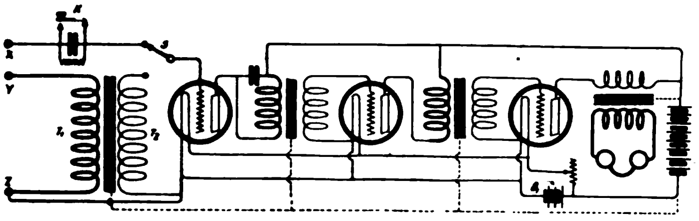


Figure 20—A three-stage amplifier used during the war

Although a little outside the scope of the present article, the design of a transformer shown in figures 14 and 15 may appeal to experimenters. These diagrams are taken from an article by the author which appeared in the November, 1919, issue of The Wireless World. Figure 14 shows stages in the manufacture of a simple transformer. A hard rubber tube about ½" external diameter and 2" long is fitted at each end of a square rubber cheek, 2" x 2", through which a ½" hole has been drilled. Wooden cheeks and a paper tube soaked in paraffin wax could be substituted for this. On this tube is wound the primary winding. This can best be accomplished by rotating the tube on the shaft of a small electric motor. The two ends of the winding should then be brought to two small terminals fixed on one of the cheeks. The secondary winding may be wound in the same direction in a similar manner, the two ends being brought out to terminals fixed on the other cheek. The greatest care should be taken to insulate the windings, which should be separated by one or two layers of varnished cloth. The iron-core consists of a bundle of iron wires 7" long which fit into the hard rubber tube and project about 2½" beyond the cheeks. The wires at each end should be parted, each half being bent round the side of the cheek. Figure 14b shows how the ends A and B and C and D have been bent round the sides of the cheeks. The ends A and B, and C and D are now worked into each other so that the core appears as two rectangular rings as shown in figure 14c. The finished appearance of the transformer is illustrated in figure 15.

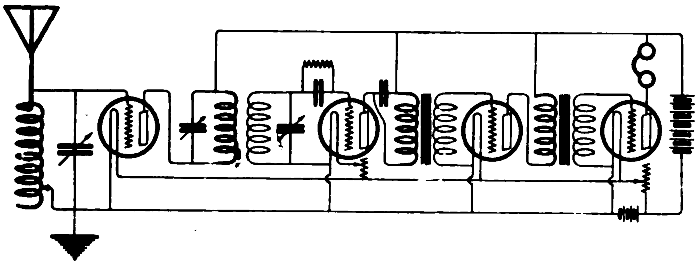


Figure 21—Circuit for high-frequency and low-frequency amplification

A second transformer T_3 T_4 is shown in figure 13. This inter-tube transformer is of the step-up type, a suitable ratio being 1 to 5. The transformer may be constructed in the manner just described, the winding T_3 containing about 3,000 ft. of wire and the secondary about 15,000 ft. These values give excellent results, but there is no reason why they should be too closely followed. Different commercial types of amplifiers vary very much indeed in the resistances of their transformer winding. Instead of connecting high resistance telephones in the plate circuit of the second tube, we conveniently use a step-down telephone transformer and low resistance receivers. It will be noted that a single cell B_2 is connected in such a position as to give the grids G_1 and G_2 a small negative potential with respect to the filament. This largely prevents any grid currents and the loss of efficiency which would otherwise result. A rheostat R of about 10 ohms resistance varies the filament currents of the two tubes simultaneously.

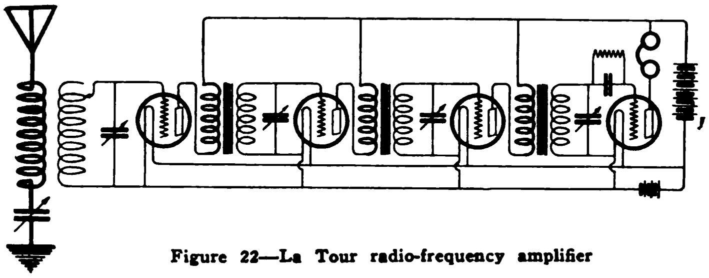


Figure 22—La Tour radio-frequency amplifier

Our next figure (figure 16) shows a useful form of low frequency amplifier which can be applied to any circuit in which low frequency current variations are taking place. The terminals I N are simply connected where the telephone receivers would normally be placed in the circuit. A special point to notice is that the author has connected the grids of the tubes to the negative side of the filament heating accumulator B_1, and so placed the rheostat R that the grids will always be slightly negative with respect to the negative end of the filament, on account of the voltage drop across the used portion of R. This arrangement is technically preferable to the use of a small cell, although an accumulator of higher emf. may be required.

A telephone step-down transformer T_7 T_8 is now shown in use. The winding T_7 may conveniently have a resistance of about 5,000 ohms and should consist of about 5,000 ft. of wire. The low resistance winding may be wound with the same wire to a resistance equal to that of the phones to be used.

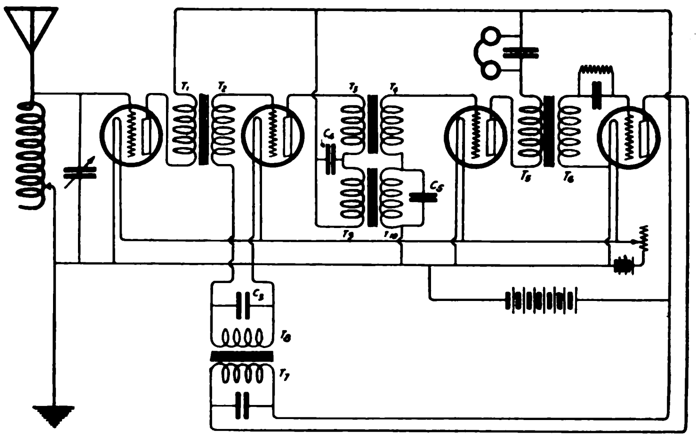


Figure 23—Four-stage amplifier designed by La Tour

Figure 17 shows a very convenient form of detector amplifier in which the first tube acts as a detector; only two tubes are shown. The input terminals are connected across the receiving circuit L_1 C_1, but it is to be understood that the terminals could be connected across *any* oscillatory circuit in which incoming oscillations are taking place. It will be noticed that a leaky grid condenser C_2 of about 0.0003 mfd. shunted by a resistance R of 3 megohms is included in the plate circuit of the first vacuum tube. Across the winding T_1 of the inter-tube transformer is connected a condenser C_3 of about 0.01 mfd., which is intended to by-pass the high frequency component of the plate current of the first tube. An obvious but very useful development of this circuit is shown in figure 18. The condenser C_2 is shown having a value of 0.00005 mfd. and R as having a resistance of 4 megohms, but these figures depend very largely on the type of tube used. The author has shown the filament current of the first tube variable by means of a separate rheostat R_1. A similar rheostat R_2 may be made to regulate the filament current supplied to the second, third, and fourth tubes, although with suitable tubes this rheostat may frequently be dispensed with.

Figure 19 shows a design of amplifier which may be used either for low frequency amplification or for the reception of wireless signals. Three terminals X Y Z are now provided. The terminals Y Z are used when low frequency amplification is desired, the switch S being placed on the stud A. When, however, it is desired to receive wireless signals, connections are made to the terminals X and Z and the switch S is placed on the stud D; the input transformer T_1 T_2 is now entirely cut out and wireless signals are rectified by the aid of the leaky grid condenser C. This condenser may be shorted by the switch K. To avoid using four terminals and also to improve the effectiveness of the amplifier for low frequency amplification, the terminal Z is connected to the negative side of the filament accumulator B_1.

A three-stage amplifier which proved very successful during the war is shown in figure 20, which is a similar circuit to figure 19, but possesses three tubes. In all these low frequency amplifiers it is almost invariably desirable to connect the iron-core of the transformers to the positive side of the plate battery H, as shown in figure 20 by the dotted lines. This steadies the action of the amplifier and lessens undesirable noises which are otherwise usually heard. Most of the improvements in these types of amplifiers are due to Marius LaTour.

If it is desired to resonate low frequency transformers used in amplifiers, large variable condensers may be connected across the windings, but such resonated circuits have not found very much favor in Great Britain and France for low frequency amplification.

Figure 21 illustrates a typical example of a circuit in which high frequency and low frequency amplification is obtained in a single amplifier employing a single filament accumulator and plate battery. The first tube acts purely as a radio-frequency amplifier, the second acts as a detector, while the third and fourth act as audio-frequency amplifiers. There are obviously very many modifications of circuits of this type, but the one given will, no doubt, be sufficient to indicate the general principle of employing single batteries and the combining of the various functions of a vacuum tube in the single amplifier. The author, however, recommends that for general experimental work it is preferable to employ a separate three-stage low frequency amplifier independently arranged, but which could be applied to any experimental circuit.

Iron-core transformers have been very largely used by Marius LaTour in France for the purpose of coupling the various vacuum tubes in a multi-stage radio-frequency amplifier used for the reception of long waves. He has used both resonated and aperiodic windings and obtains a step-up effect which is not obtainable to the same extent in the case of an air-core transformer. Figure 22 shows an arrangement of vacuum tubes used by LaTour for radio-frequency amplification. The disadvantage of this class of amplifier is that it does not lend itself to reception over wide ranges of wave lengths and is, moreover, difficult to design. LaTour has also devised an amplifier which is shown in figure 23. Four stages of amplification are shown, the last tube acting as a detector. The transformers T_1 T_2 T_3 T_4 and T_5 T_6 are designed for radio-frequency amplification. The last tube acts as a detector and the rectified pulses in the plate circuit are passed into the primary step-up transformer T_7 T_8, the winding T_8 being included in the plate circuit of the second tube. A condenser C_3 is shunted across T_8 to allow the passage of radio frequency current. The second tube now amplifies the low frequency pulses at the same time as it is amplifying the high frequency energy supplied by T_1 T_2. The low frequency amplified pulses pass through the primary T_9 of a step-up transformer T_9 T_{10} which is included in the plate circuit of the second tube and in series with the winding T_3. The secondary T_{10} is included in the grid circuit of the third tube and is in series with the winding T_4. Condenser C_4 and C_5 are connected across T_9 and T_{10} to by-pass the radio-frequency current in these circuits. The telephones T are included in the plate circuit of the third tube. The type of amplifier shown does not seem to have achieved the success that might have been expected from a double magnification circuit of this kind.

From the foregoing remarks it will be seen that a very large number of amplifier circuits may be devised. As a rule, it is preferable to aim at high selectivity and the reception of very weak signals rather than merely to obtain a very loud response in the telephones; consequently, attention is to be called chiefly to those circuits employing radio-frequency amplification.

An Oriental Radio Set

By Howard S. Pyle

WE are hearing considerable discussion of various new radio apparatus brought out during the period of hostilities, but very little has appeared in print descriptive of the marine apparatus in use by the Japanese vessels.

This equipment has remained substantially the same for some years. It has, and is, proving very efficient and satisfactory in the long voyages in the trans-Pacific trade. A Japanese operator is often able to clear with a Japanese station and one in North America on the same night. This means spanning two thousand miles of water each way, and in spite of the many records made in both transmission and reception during the war, the almost nightly long distance work of the Japs is not to be scoffed at.

The writer, shortly after our entry into the war, had the good fortune to be assigned to a large steel freighter which the United States had purchased from the Japanese government, and which was equipped with the "Annaka" type of apparatus. We were to sail for South America and then the east coast, to enter into the trans-atlantic transport service. Having a civilian crew, although we were all naval operators, we saw a splendid opportunity for experimentation with the Japanese apparatus, and we were left entirely alone, having absolute control of the radio.

Reporting aboard our vessel, formerly the *Yoshida Maru 3d* but renamed the *Eastern Chief*, we were agreeably surprised at the excellent appearance of the apparatus. It was mounted entirely on marble, all the metal parts being nickel plated. Even the smaller instruments, such as starting boxes and field rheostats, had individual marble panel mountings. The receiver was very elaborate and enclosed in a mahogany cabinet with a heavy hard rubber top, all the controls and metal parts being silver plated. A solid oak operating table with drawers and files was installed, and a built-in settee of oak with green plush cushion added to the operator's comfort.

Our stateroom was connected by a door with the operating room, and a speaking tube connected us with the chart house. The location in the starboard wing of the bridge was also desirable.

Starting box and power panel for main 3 kw. set

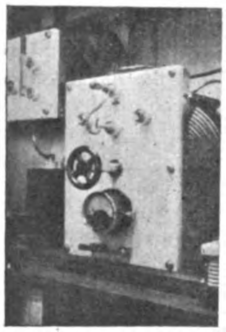
Loading coil panel and antenna switch

As to the apparatus itself: the transmitter was of three kilowatt capacity for the main set, with an auxiliary generator and transformer of half-kilowatt size, which, when cut in, used the same oscillating and open circuits as the main set, the change being effected by merely shifting transformers and starting the small generator. A separate power control panel was provided for both motor generator units, and contained all the controlling appliances with the exception of starting boxes and field rheostats which were mounted individually, convenient to the operator's hand. The auxiliary motor generator was powered by a fifty-volt storage battery, contained in a suitable housing on the bridge. Circuit breakers and the necessary controls for charging were contained on the power panel. The ship's mains, of course, furnished current for the operation of the main transmitter. The generator sets, while bearing Japanese nameplates, were evidently of General Electric type, and consisted of the usual DC motors, coupled to the generators with flexible couplings. The generators were of the solid rotor type, the main set being of 600-cycle frequency and the auxiliary of 500 cycles.

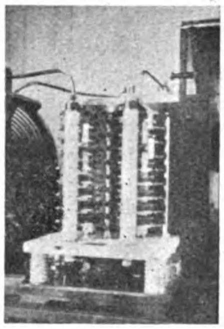
The transformers were of low secondary potential and of closed core design, immersed in oil. A removable plate on the top of the cases permitted of easy access, by means of a small forked wire, to single-pole-double-throw switches immersed in the oil, and which controlled the secondary potentials. Leads from the transformer were connected directly across the condenser, consisting of two large units of glass plates and copper foil, embedded in beeswax, and contained in a suitable case. A heavy single-pole-single-throw switch, permitted of change in capacity, which was necessary for operation at the 300-meter wave length. This switch was mounted on a marble panel which formed the cover of the condenser case.

The quenched gap, which appears in one of the illustrations, is probably the most unique instrument in the transmitting equipment. This consisted of sixteen plates, mounted vertically in two rows, and having a geared edge on one plate of each gap. A series of fiber gear wheels moving on a shaft passing between the two sets of plates, engaged the teeth in the gap plates. A small tube led from the sparking surface of each gap to a larger feed pipe, and thence by a rubber tube to an alcohol chamber. A motor actuated bellows, forced the alcohol vapor onto the sparking surfaces, assisting in the quenching. The blower motor, by means of a system of chains and gears, also caused the plates to slowly revolve while the alcohol was forced onto the plates. By this means the whole surface of the gap was presented to the alcohol blast. The mica rings separating the sparking surfaces gave trouble for a while by leaking, but after a little experimenting we remedied this.

In series with the gap and condenser was the primary of an auto transformer, the almost perfect quenching of the gap permitting the use of this type of inductance in place of the customary oscillation transformer and still insuring a pure wave. The inductance was variable by means of a large wheel fronting on the marble panel which supported the auto transformer, and which may be plainly seen in one of the accompanying photographs. On this panel was also mounted the hot wire ammeter and the wave changing switch, which latter consisted of three plug sockets for the insertion of a plug connected by flexible cable to the circuits. A similar plug arrangement was in use on the loading coil panel. The loading coils themselves, were, as was the auto transformer, wound in the well known pancake style. As the Japs work their own stations on a wave length of 1,700 meters when interference is heavy on the 600 meter wave, several loading coils were installed, but ours had been connected in circuit to permit a range of waves from 300 to but 952 meters, hence several coils were removed. A heavy single-pole switch on the front of the loading coil panel provided for short-circuiting the loading coils at will.



Auto transformer and control panel showing wave changer switch

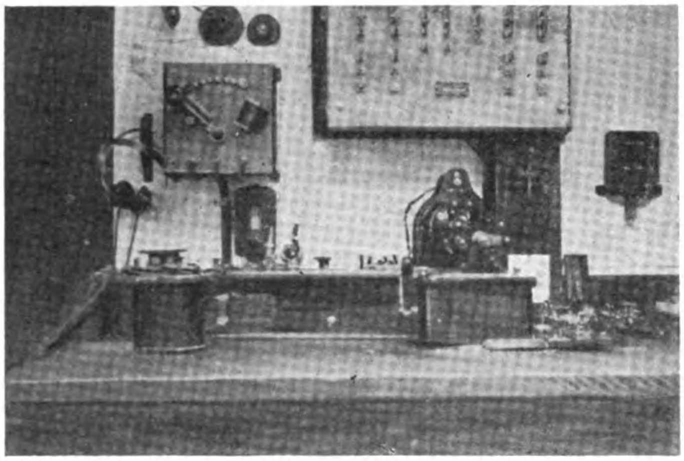


Sparkgap of novel design and unique operation

From the loading inductance, the circuit went to the antenna switch, which was a single-bladed affair with a throw of 60 degrees. The primary power circuits and the blower motor for the gap were controlled by this switch as well as the high frequency circuits. A deck insulator of massive dimensions and heavy porcelain construction carried the lead to the antenna. Contrary to the usual United States custom of using 7/22 phosphor bronze for the antenna, the Japanese use a cable of seven strands of number 14 phosphor bronze, which makes a very heavy, but at the same time, efficient high frequency conductor. In place of our usual Electrose insulators, two heavy 10-inch ribbed porcelain insulators, heavily glazed were in tandem at both ends of each strand. The lead in was brought from the middle and was not bunched until reaching the deck insulator. Our antenna had a natural period of 310 meters, which made a series condenser necessary for transmission on 300 meters.

Two hand keys of massive dimensions were provided, and as these were of the old massive pump handle type, we pulled them out and installed a smaller navy key.

As has been stated, the receiving set was elaborate. Of the older cabinet type rather than the more recent panel design, it was a marvel of intricacy. A bird's-eye view of the top of the cabinet had the appearance of the letter E with the middle leg left out. In the narrow part, a small drawer was set, which served to hold spare crystals, etc. A loose coupler of about 3,000 meters held the right hand side and provided for the inductive transfer. The primary was varied by a slider moving on a rubber strip which carried thirty switch points. A similar slider, but working on a worm gear from the inside of the coil, varied the secondary inductance. This was controlled by a small crank projecting from the secondary head. A loading inductance was mounted within the cabinet, controlled by the usual dial switch on the panel, and was used for considerable of the rough tuning. A fixed condenser, made up similar to a variable by using spaced aluminum plates, but stationary rather than movable, was controlled by a five point plug switch on the panel. A similar plug switch controlled a smaller paper and tinfoil condenser across each variable and the telephones. A variable was connected in shunt to the secondary and a primary variable was thrown in shunt, series or short circuit by another plug switch. A dial switch controlled a non-inductive potentiometer, which could be used with either of three crystal detectors, using foreign minerals which we couldn't analyze. Binding posts were provided for connection of the wing, grid and filament circuits of a vacuum tube detector, but none was provided, so we arranged our own tube. An extremely intricate switch contained within the cabinet and controlled by a handle on the outside, served to change the hookup for crystal or vacuum tube work. We found it to be poorly arranged for tube reception but very efficient on crystal.



The receiving set showing a compact arrangement of instruments

In making the diagram of the connections of the receiver, two whole evenings and several choice bits of temper were used up in tracing the circuits. The wires connecting the various instruments in the cabinet made a bundle the size of a man's wrist, and we thought a considerable loss of energy in vacuum tube work was due to the presence of so much useless inductance. The telephones were probably the one real discredit to the outfit, and they were as good as worthless. Single pole construction, apparently of a low resistance and cheaply constructed, we had trouble with them continuously until we substituted a pair of navy 'phones.

We made several noteworthy transmissions, but I believe our record was hung up, when, by some freak or other, we communicated with San Diego, California, at 2,000 miles in daylight, and during July, when we were somewhere around the equator. This was purely freak work, but our night transmissions of ordinary occurrence gave clear signals easily readable at from 1,400 to 1,800 miles regularly.

The hot wire ammeter showed only about 14 amps. on our highest power, which only serves to show that the hot wire ammeter is really very much of a liar, for it has been proven time and again, that a high reading at the meter does not necessarily mean great energy from the antenna. I have done far less distance with ammeters showing as high as 20 and 22 amperes, and have come to take the meter reading as merely an indication of what you are really getting in the circuits, not what is hopping off into space.

On the whole, we were well satisfied with the performance of our Oriental outfit, but were relieved to exchange it for a navy set. Its complicated construction kept both myself and my two assistants constantly on the job to keep it going right, and often when high power work was attempted, two or three of us would have to stand by for emergency breakdowns. Nevertheless, we take off our hats to our little yellow brothers for their remarkably fine workmanship and attention to detail and to the results they succeeded in getting as a regular occurrence—not as freak work. We were handicapped in having to trace all our circuits, as everything was lettered with nameplates in Japanese, and next time, we hope to have the pleasure of accepting a Japanese set lettered in English—or at least with a blueprint under the mattress.

U. S. S. Easternchief, formerly Yoshida Maru 3d, in Scheldt River near Antwerp, Belgium

In the June Wireless Age

A New Three-Electrode Vacuum Tube
An Oscillating Current Generator

Two articles that will prove interesting

Radio Frequency Inductance Coils

By M. K. Zinn

SUMMARY: The purpose of this paper is to discuss some of the practical considerations which enter into the design of inductance coils for radio frequencies, with particular reference to their application in circuits intended for the reception of long undamped waves. The theoretical behavior of coils at high frequencies is reviewed, and for illustration, impedance measurements on a typical antenna load coil are presented.

GENERAL THEORY: The problem of designing a coil to function within a particular band of frequencies usually presents itself in this form:

To design a coil which will have a given inductance with the smallest possible resistance consistent with cost.

At relatively low frequencies, the impedance of a coil approaches $R + jpL$ where R and L are respectively its direct current resistance and inductance and $p = 2\pi f$.

At radio frequencies, however, the impedance departs from this ideal value chiefly by reason of two influences:

1. Distributed capacity.
2. Skin effect.

DISTRIBUTED CAPACITY: For practical purposes, the distributed capacity of a coil may be represented by a fictitious lumped capacity, C, shunted across its terminals. The magnitude of C may be found experimentally by measuring the self-resonant frequency of the coil when excited by a wavemeter very loosely coupled to the same. A better method is to measure the impedance of the coil with an impedance bridge properly shielded and arranged to give accurate results at high frequencies. C may then be computed from the frequency at which the angle of the impedance reverses its sign, knowing the low frequency inductance of the coil

Tests indicate that this equivalent capacity is independent of the frequency for ordinary types of coils. We may represent an inductance coil, then, by the schematic circuit of figure 1, where R and L are the direct current resistance and inductance, respectively, and C is the equivalent capacity defined above.

At this point it becomes necessary to differentiate between two methods of connecting the coil in the circuit, viz.: (1) whether the acting voltage is applied externally, or (2) induced internally, with respect to the coil. The use of a coil as an antenna load inductance is representative of the first case. The secondary coil of a coupling transformer is representative of the second case. Figure 1a shows the circuit that must be considered in finding the impedance offered to an external e. m. f. Figure 1b shows the circuit that must be considered in finding the impedance offered to an internal e. m. f.

In the first instance, the impedance $Z = \dfrac{e}{j}$ is

$$\frac{R + jpL}{jp\,RC + (1 - p^2\,LC)}$$

Separating this expression into its real and imaginary components we find respectively the effective resistance and reactance:

$$R_{eff} = \frac{R}{(pRC)^2 + (1 - p^2\,LC)^2}$$

$$X_{eff} = \frac{pL\,(1 - p^2LC) - p\,R^2\,C}{(pRC)^2 + (1 - p^2\,LC)^2}$$

For coils of the type used in radio work, the terms pRC and pR^2 C are very small and negligible in comparison with $(1 - p^2\,LC)$ at all frequencies except those very near the self-resonant frequency, or "critical" frequency, of the coil (i.e. where $1 - p^2\,LC = 0$); so that the effective resistance and reactance are approximated very closely by the following:

$$R_{eff} = \frac{R}{(1 - p^2\,LC)^2}$$

$$X_{eff} = \frac{pL}{1 - p^2\,LC}$$

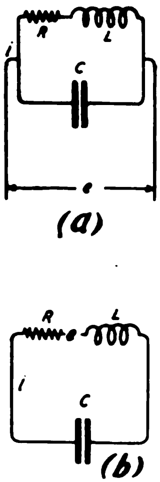


Figure 1

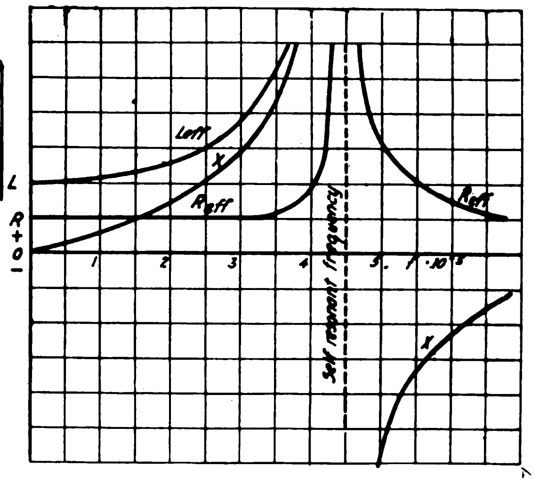


Figure 2

Figure 1—Schematic circuit of an inductance coil. Figure 2—Theoretical curves showing the action of a coil when the acting e. m. f. is applied externally

The effective inductance is then,

$$L_{eff} = \frac{L}{1 - p^2\,LC}$$

The effective resistance of a coil is a measure of its efficiency since it determines the current that will flow at resonance when the coil is used in a series resonant circuit. From the above relation we see that this effective resistance is increased over the d.c. resistance by the factor $\dfrac{1}{(1 - p^2\,LC)^2}$. This increase is attributable to the capacity of the coil alone, and is quite independent of the increase in resistance due to skin effect.

The effective inductance of the coil in like manner has been increased by the factor $\dfrac{1}{1 - p^2\,LC}$. For practical purposes, we are interested only in the frequency range below the critical frequency of the coil. At higher frequencies the coil has negative reactance, that is, it no longer functions as an inductance.

The behavior of a coil when the acting e.m.f. is applied externally is illustrated in the theoretical curves of figure 2.

It may be of interest to note in passing that the capacity of a load coil may indeed have quite a beneficial effect in eliminating short wave interference. For example, the writer has a long wave receiver employing several load coils immediately beneath the antenna. These coils quite accidentally have different self-resonant frequencies pretty well distributed over the short-wave spark range. The result is that neighboring spark station interference is very completely choked out, while otherwise these short wave signals would come in through the coupling capacities and cause trouble, even if the secondary circuit were tuned to 10,000 meters or more.

In the second instance (figure 1b), where the coil is so located that the acting e.m.f is internally applied, the distributed capacity effect does not increase the effective resistance of the coil. The effective inductance is changed by a small amount depending upon the dimensions of the remainder of the circuit. In fact, in this case, the effect of the coil capacity is unimportant and entirely negligible, at least if the tuning condenser associated with the coil is sufficiently large in comparison.

Skin Effect: The second influence which causes the effective resistance of a coil to depart from its ideal d.c. value is the well-known "skin effect."

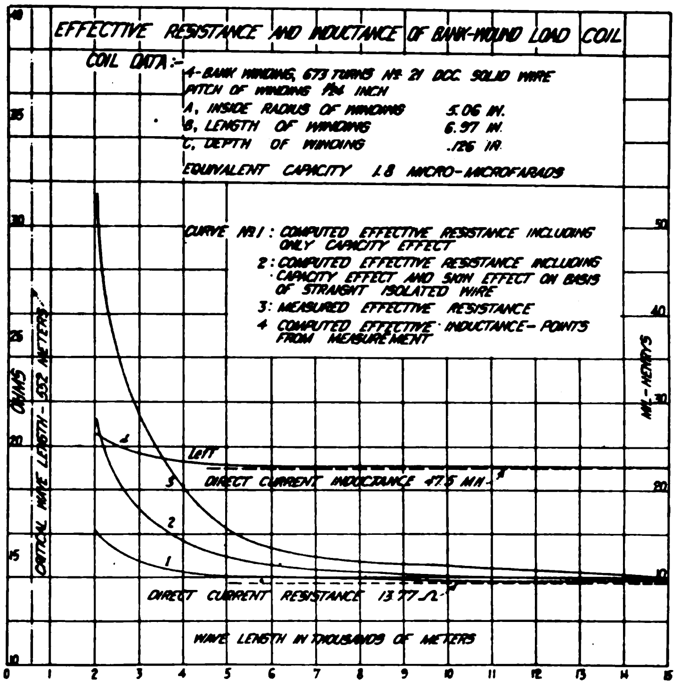


Figure 3—Graphic curves giving the results of calculation and measurement on a sample coil

Unfortunately, the magnitude of this effect cannot be accurately predicted when the conductor is wound into any form of multilayer coil. In general, however, the skin effect appears to be considerably greater in a multilayer or bank-wound coil than in a single layer coil, the skin effect in the latter being in turn greater than that in a straight wire remote from other portions of the circuit.

In default of an accurate formula for predetermining the skin effect in multilayer coils, the designer must resort to his accumulation of test data on coils of various dimensions. The results of impedance measurements on a four-bank load coil are presented below and may serve as a rough guide in estimating the increase in effective resistance due to skin effect for coils of similar construction.

Example: Table I and the curves of figure 3 present the results of calculation and measurement on a sample coil. This coil consisted of a four-bank winding of No. 21 D.C.C. solid wire on a threaded bakelite tube 6 inches in diameter. Specific dimensions are given on figure 3.

As a basis for calculation, the self-resonant frequency of the coil was first determined by the simple wavemeter arrangement sketched in figure 4. This measurement gave the equivalent lumped capacity, C. The D.C. inductance of the coil was computed from Brooks and Turner's data offered in bulletin 53 of the University of Illinois.

From these data it was possible to compute the effective resistance including the increment due to the capacity effect but exclusive of that due to skin effect, from

$$\frac{R}{(1-p^2LC)^2} \text{ (Curve 1).}$$

For purposes of comparison, the effective resistance was again computed taking also the skin effect into account on the basis of a straight isolated wire—from

$$\frac{RK}{(1-p^2LC)^2} : \text{(where K is the "resistance ratio," } \frac{R}{Ro}\text{,}$$

given in "Radio Instruments and Measurements." (Wireless Press, N. Y.) These results are plotted on curve 2.

Impedance measurements were then made to determine the magnitude of the actual skin effect in the banked winding. The measurements in question were made by means of the radio frequency bridge sketched in figure 5. Although elementary precautions were taken to maintain a balance between the capacities to ground of the various corners of the bridge, it was found that shifting the apparatus changed the balance point noticeably, so that an accuracy greater than 5 per cent. is not claimed for the results.

Table I summarizes the increments in effective resistance contributed by the capacity and skin effects. The effective inductance apparently did not suffer any appreciable deviation from the theoretical values computed from the capacity effect formula along: $\frac{L}{1-p^2LC}$. The inductance curve has been plotted from these calculations. The points on the curve represent the results derived from the impedance determinations.

Types of Coils: By far the most practical and convenient information available for the rapid computation of the inductance of coils of all shapes is contained in bulletin 53 of the University of Illinois by Brooks and Turner. The results obtained from these data are sufficiently accurate for engineering work.

This paper assigns to all coils three characteristic dimensions, viz.: a, the inside radius of the winding; b, the length of the winding; and c, the depth of the winding. It is shown that a given length of wire will have a maximum inductance when wound into a multilayer coil of the relative proportions, a:b:c = 1:1.2:1, approximately. Coils containing the same length of wire but of different proportions will have a lesser inductance equal to a "shape factor," Fo, times the optimum inductance. Curves for Fo in terms of the fundamental dimensions a, b, c are given in the bulletin.

If we accept these relations, we may draw certain instructive conclusions regarding the relative efficiencies of various types of coils for radio work, keeping in mind that our problem consists in designing a coil for a given inductance with the smallest possible resistance consistent with cost.

Coils employed in circuits intended to receive long wave signals, i.e., 5000 meters or more, fall into three classifications:

1. Single layer coils.
2. Multilayer coils.
3. Bank-wound coils.

As stated above, the effective resistance of a coil is an inverse measure of its efficiency. This effective resistance may be expressed as

$$R_{eff} = R + R_c + R_s$$

where R is the direct current resistance, R_c is the increment in resistance caused by the distributed capacity effect, and R_s is the increment in resistance caused by the skin effect.

The single layer coil possesses a decided advantage in that it suffers a smaller resistance increment due to capacity and skin effect. However, for a given inductance, such a coil requires a very much greater length of wire and therefore has a much greater D.C. resistance than a coil of the same inductance wound in either of the other two forms. A glance at the curves of figure 3 will show that for long wavelengths, the D.C. resistance R is decidedly the largest term in the total, $R + R_c + R_s$. For wavelengths in excess of 5000 meters, therefore, a bank-wound coil is many times more efficient than a single layer coil. Brook's shape factor data shows, in fact, that a single layer coil may have a D.C. resistance as much as ten times the D.C. resistance of a bank-wound coil of the same inductance. For long waves, some form of multilayer coil approaching the maximum inductance shape is nearly always even more efficient than a bank-wound coil. The reason is, in brief, that the increase in resistance due to the greater capacity and skin effect in the multilayer coil is more than made up for by its smaller direct current resistance, since the latter comprises the major part of the total effective resistance at these frequencies.

Of course, for short wavelength circuits the reverse is true; that is, when the frequency is high enough to cause $R_c + R_s$ to become comparable in magnitude with R, the single layer coil may be the most efficient.

A type of coil called the "honeycomb-wound" coil has recently appeared on the amateur market. It is a multilayer coil with the layers wound askew so as to enable the turns to be spaced while still retaining the desirable multilayer maximum inductance form. The spacing of the turns is no doubt quite effective in reducing the increments R_c and R_s. At the same time it is obvious that for a given inductance a greater length of wire is required due to the less compact nature of the coil, which increases R a certain amount. Whether the total R_{eff} is reduced by the scheme depends of course upon the relative magnitudes of these two opposite effects for a given frequency range.

The term R_s can be most effectively reduced by the use of litzendraht wire in place of solid wire. At high frequencies, where R_s occupies a formidable proportion of the total, R_{eff}, litzendraht is highly desirable. For long wavelengths, however, its desirability becomes more questionable. The choice between solid and litz-conductor must be governed by the practical consideration of maintaining a balance between the increase in efficiency and the accompanying increase in cost.

For example, in the case of the load coil whose effective resistance is shown on figure 3, it would have been decidedly uneconomical to use litzendraht braid. At the minimum wavelength for which this coil was designed, 5000 meters, $R + R_c$ is 14.1 ohms and R_s is 2.1 ohms. Assuming for the moment that the use of an equivalent litz braid would have eliminated the skin effect entirely, the resulting gain in efficiency would have been about 15 per cent. at the same time, the cost of the coil would have been increased about 225 per cent. This increase in cost might possibly have been justified had the coil been intended for use in a standard measuring circuit, but never in the case of its application to a practical receiving circuit; since a 15 per cent increase in audibility can be gained far more cheaply by a few modifications in the amplifier.

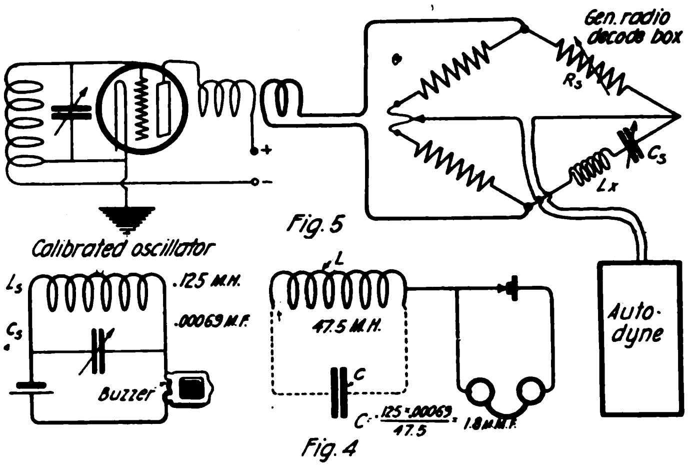


Figure 4—Simple wavemeter arrangement used in making calculations
Figure 5—Radio frequency bridge used in measuring impedance

NOTE: The resistance increase caused by dielectric loss in the insulation of the wire is entirely negligible at frequencies lower than 60 kilocycles, in comparison with the three terms just mentioned.

TABLE I

Characteristics of 47.5 Milhenry Load Coil

Wave Length, Meters λ	$\frac{p.10^{-6}}{} = \frac{600\pi}{\lambda}$	p^2 LC	$1-p^2LC$	KR computed on basis of isolated straight wire U. S. B. of S. Bulletin 74, table 19, p. 311, and formula 209	R_{eff} on straight wire basis $\frac{KR}{(1-p^2LC)^2}$	R_{eff} from test results	R_c increase in R_{eff} due to capacity effect $R\left[\frac{1}{(1-p^2LC)^2} = 1\right]$	R'_s increase in R_{eff} due to skin effect on straight wire basis $\frac{R(k-1)}{(1-p^2LC)^2}$	R_s increase in R_{eff} due to skin effect—from test results—by remainder	L_{eff} computed from $\frac{L}{1p^2 LC}$
300	6.28	3.37	-2.37	41.3	7.36					
500	3.77	1.215	-.215	33.9	734.					
600	3.14	.844	.156	30.42	1252.					302.5
700	2.69	.618	.382	28.36	194.4					124.9
1,000	1.884	.304	.696	24.23	50.00					68.1
2,000	.942	.0759	.9241	18.18	21.30	31.5	2.37	5.16	15.36	51.4
3,000	.628	.0337	.9663	15.97	17.10	21.3	.98	2.35	6.55	49.1
4,000	.471	.0190	.9810	15.15	15.73	18.0	.53	1.43	3.70	48.4
5,000	.377	.0122	.9878	14.60	14.95	16.2	.34	.84	2.09	48.1
10,000	.188	.0030	.9970	14.05	14.14	14.5	.08	.29	.65	47.6
15,000	.126	.0013	.9987	13.86	13.90	14.0	.04	.09	.19	47.6

EXPERIMENTERS' WORLD

Views of readers on subjects and specific problems they would like to have discussed in this department will be appreciated by the Editor

A Spark Coil Panel Transmitter

By Thos. W. Benson

IN the design of spark coil panel it is not sufficient that we merely group the apparatus as conveniently as possible; an effort should be made to centralize and simplify all variable factors so as to make them easily and quickly adjustable. In spark coil design it is difficult to calculate the values of capacity and inductance required, hence we make them adjustable, actual tests determining the proper values. Furthermore, the modern spark coil set must be inductively coupled with the antenna, or trouble is sure to result from interference with other stations.

The set described here possesses several novel features, including a quenched gap as well as an easily adjustable oscillation transformer. Figure 1 illustrates a front view of the panel with the apparatus assembled. For the sake of clearness the secondary of the oscillation transformer is omitted.

The panel may be made of bakelite or fibre. Any hard wood, however, will serve if insulating washers are used in mounting the live parts.

The panel, which should measure 12" x 15", is attached by braces to a base 12" x 10".

A hole is cut in the lower left corner of such a size that the interrupter on the spark coil mounted in the rear can be adjusted. A switch occupies the lower right corner.

Above the interrupter is mounted the quenched gap. This comprises two brass rods ½" square, and 1¼" long, mounted 1½" apart. The upper rod is drilled and tapped to take an adjusting screw 1" long which serves to hold the gap elements together. The elements of the gap are made from a strip of copper 1" wide and ⅛" thick. This strip is cut up into one inch lengths and all corners neatly rounded with a fine file. The faces of the elements are polished up on fine emery or sand paper. Eight elements suffice for a one-inch coil, the exact number to be determined by test.

Separators one inch square are cut from mica .005" thick, a hole ⅝" in diameter being cut in each with sharp pointed dividers. In assembling the gap, alternate pieces of copper and mica are piled up, the edges made even by tapping on a flat surface and then clamping them between the brass posts rather tightly.

The condenser for a one inch coil can be made by placing 7 plates of tinfoil or thin copper or brass 4" x 6" between sheets of glass 6" x 8". Four of the plates have lugs brought out to a common terminal, the other three plates being brought out separately for the purpose of varying the capacity. The usual practice of coating the plates with vaseline should be followed, clamping them between two pieces of wood 6" x 8".

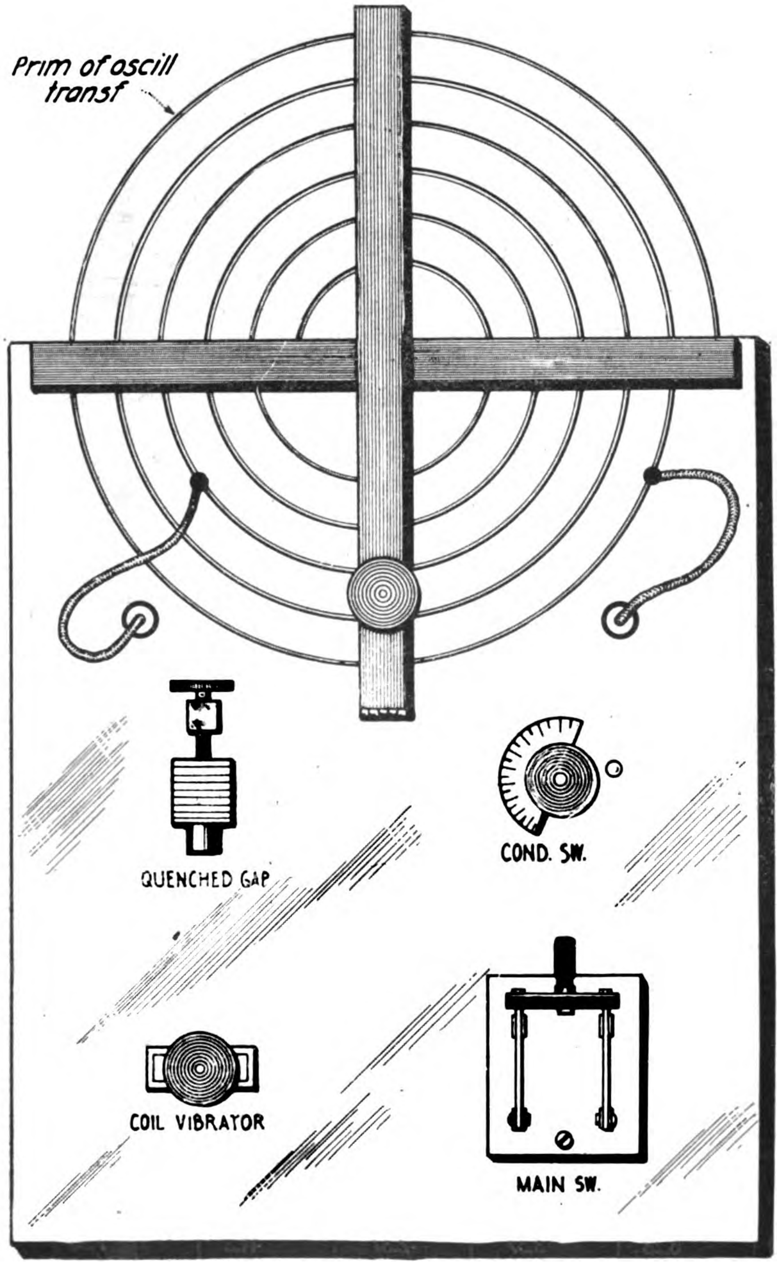


Figure 1—Front view of panel with apparatus assembled

The condenser unit is held upright behind the panel by 4 brass clips as shown in the side view, figure 2. A 3-point multiple switch on the front of the panel controls the capacity. This is made in the usual manner from a semi-circle of thin copper with a radius of 1", fitted to an insulating knob. The copper is split near the edge with a pair of snips, 3 contacts connecting to the condenser plates being mounted so that the copper contactor travels over them.

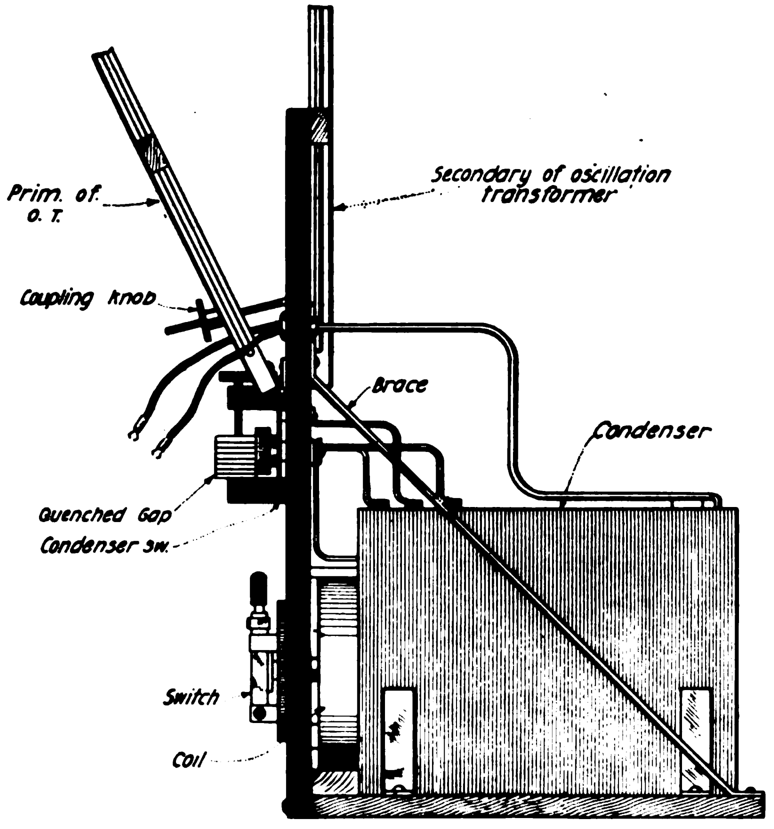


Figure 2—Side view of panel showing condenser unit, oscillation transformer and other apparatus in place

The oscillation transformer is simple in construction, the primary and secondary being identical. The cross is made from ⅜" x ¾" strips, notched and glued together. Before assembling, holes are laid out and drilled in the arms to pass No. 10 copper wire. It is preferable to use stranded wire or difficulty will be experienced in threading the wire through the holes. If preferred, slots can be cut for the wire in place of holes, thus simplifying the assembly. The turns are ¾" apart, starting 1½" from the center, making 5½ turns.

The secondary is mounted on the rear of the panel as shown in figure 2. The primary is mounted on the front, being pivoted at the bottom by a small brass hinge. The adjustment for coupling is obtained by means of a threaded rod shown in the side view. One end of this rod is fitted with two nuts jammed together and slipped through a slot in the panel. The primary is slotted directly opposite and the rod passing through has a knob threaded on it. The slots permit the up and down movement of the rod when the coupling is varied by turning the knob.

The flexible leads to the primary are passed through holes in the panel properly bushed to prevent leakage of the high voltage current.

The hookup presents no difficulties. Stranded wire is preferred. Binding the wire in smooth curves and keeping it away from all supports maintains the efficiency. No connections are made to the front of the set. Binding posts for the primary current should be mounted on the base at the rear. This leaves a clean panel with no wires at the front, making unnecessary the drilling of the operating table.

The wiring diagram shown in figure 3 shows the preferred method of wiring in the aerial switch. This reduces leakage across the switch, permitting the use of a smaller and more compact aerial switch. In addition, the lead can be brought directly to the secondary of the oscillation transformer, making a much neater installation.

It should not be necessary to dwell on the advantages of this set. By marking the inductances with different values of capacity the set may be tuned for three or more wave-lengths. In this connection it might be well to state that for local work it is best to cut down the wavelength to 150 meters or so. This will enable a spark set to get through when a number of sets are working around 200 meters. For maximum distance, however, the wave length should be run up to the limit, 200 meters.

Most Government stations do not tune lower than 300 meters, so even if you run over 200 and emit a sharp wave, little interference will result. By all means, keep the wave sharp. It is easily accomplished with an inductively coupled set as described. Watch your operating range increase.

For other than a one inch spark coil the size of condenser and number of gap elements will be different. For a ½" coil, use 5 plates in the condenser and about 4 elements in the gap; for a 2" coil, use 9 plates in the condenser and 12 or 14 elements in the gap. The panel described will permit of the change of power, the gap being designed to take more elements, and the condenser can be increased by adding plates. One of each pair of additional plates can be connected permanently to the condenser switch.

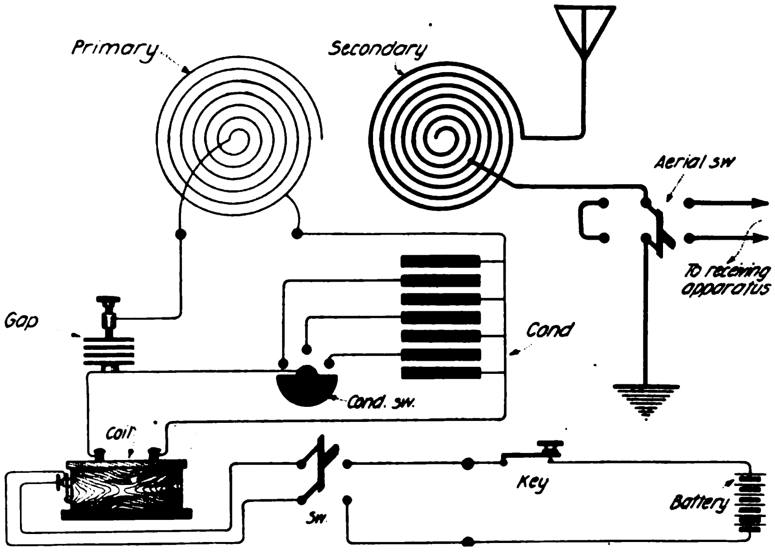


Figure 3—Wiring diagram used in the spark coil transmitter

Multi-layer Inductances for Long Wave Work

By Frank V. Bremer

FOR many obvious reasons coils of rectangular cross section are much more convenient than single layer solenoids when one wishes to effect reception at the longer wave-lengths.

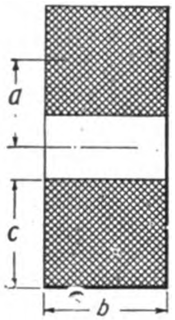


Figure 1

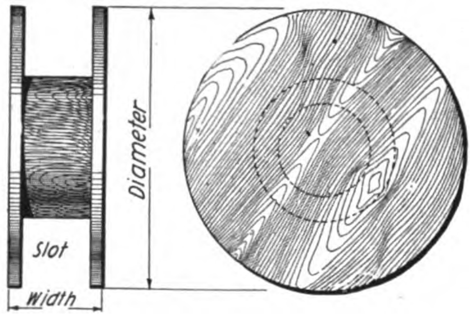


Figure 2

Figure 1—Dimensions used in the formula. Figure 2—Constructional details of block used for winding the coils

Not only are there physical advantages arising from decrease in amount of space taken up by the coil but there are no electrical disadvantages which will in any way materially affect the results to be obtained when coils of rectangular cross section are used. The usual large single layer loading inductances are very awkward to handle and there is always the disadvantage that, by reason of the comparatively low value of distributed capacity which the long solenoid has, any movement of the hand in the immediate neighborhood of the long coils changes the effective distributed capacity. As a result the wave-length of the circuit of which the coil is a part is also changed. In the case of the multi-layer coils, the distributed capacity is not only considerably higher, but the electrostatic field of the coil is so concentrated that the proximity of foreign bodies has no appreciable effect upon the wave-length of the circuit of which the coil is a part.

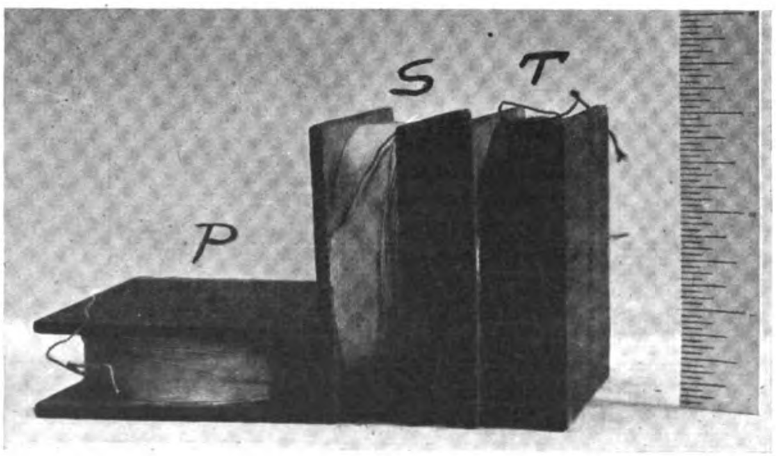


Figure 3— Rectangular cross section coils constructed by an amateur in New York

Although it is considered best practice to use single layer solenoids when dealing with shorter wave-lengths, it is possible to build and use multi-layer coils of rectangular cross section on the shorter wave-lengths.

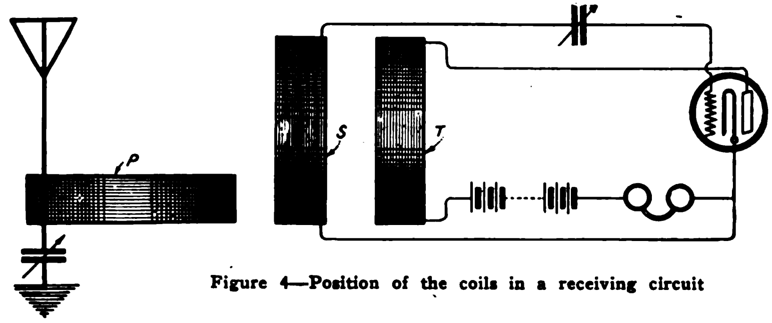


Figure 4—Position of the coils in a receiving circuit

Formulas for the calculation of multi-layer inductances of rectangular cross section are to be found in the circular of the Bureau of Standards No. 74, "Radio Instruments and Measurements." In the formula

$$L = \frac{4\pi n^2 a^2}{.2317a + .4466b + .39c}$$

a very fair approximation of the inductance value of a multi-layer coil of rectangular cross section may be obtained. Here *n* equals the number of turns, *a* the mean radius, *b* the width, and *c* the radial depth in centimeters. See figure 1. For example, assume that we wish to construct a coil to work up to 10,000 meters in conjunction with a variable capacity having a maximum value of .001 microfarad. Using the formula, $\lambda = 59.6 \sqrt{LC}$, we determine that approximately 28,000,000 cms. inductance will be required. Ignoring the distributed capacity and assuming that the coil is to be 6" outside diameter and 1" wide and the winding to have a radial depth of 1", we find by solving the equation for *n* that it will be necessary for us to place within this space (1" x 1") approximately 910 turns of wire. It will then be necessary, of course, to choose a size of wire such that it will be possible to place this number of turns within the space allotted, but if only a certain size of wire is available for use, a certain number of turns in a certain area may be assumed and the formula solved for *L* which being too large or too small, a new assumption is made, etc.

For undamped wave reception in conjunction with vacuum tube detector, three coils will be required, viz., a primary, a secondary and a tickler coil. The coils are all constructed in a similar manner, the only difference being in the dimensions, these varying with the wave-lengths. A solid block of close-grained wood, such as birch, of a size suited to the dimensions of the coils to be constructed, is selected and placed in a lathe. This block is turned round to the correct diameter and width. Without removing it from the lathe a slot of square cross section, figure 2, is turned in and the whole given a smooth finish.

A layer of bond paper, about .01", is then laid in the bottom of the slot and the winding is begun by placing a layer of wire upon the paper, being sure to have the turns all even and to fill the layer up full. Another layer of bond paper is then laid over the first layer of wire and the winding is continued, a layer of paper being placed over each layer of wire, etc., until the slot is completely filled up.

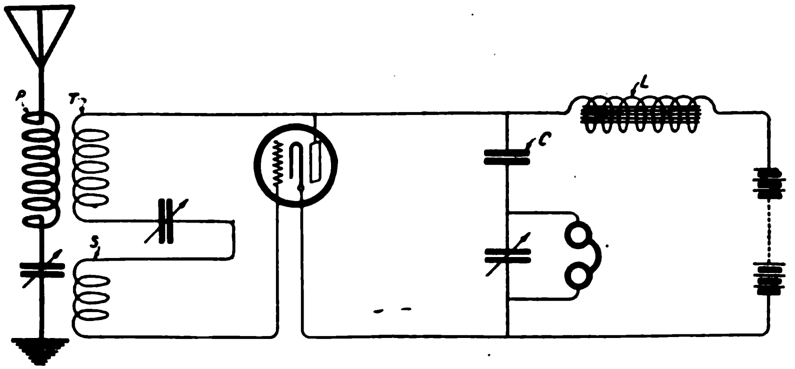


Figure 5—Wiring diagram of a circuit that gives considerable amplification

For use in conjunction with the average amateur antenna it will usually be found desirable to construct two coils of the same dimensions for each range of wave-lengths chosen, one of these for use as a primary and the other for use as a secondary. The tickler coil may be made smaller and usually a value of inductance about one-third that of the secondary is sufficient. Because of its lower resistance, it is desirable to use Litzendraht, but solid wire may be used with excellent results. No taps should be taken off from any of these coils.

For those who may have difficulty in having the forms for the winding of the coils turned out a substitute may be made by obtaining two pieces of close-grained board ¼" thick and cut to the desired size. Next obtain a round piece of wood of the proper diameter, divide each piece of board so as to get the exact center, and glue a piece of round stick between the boards, but do not fasten the pieces together. The winding is done about as outlined above. Some dimensions of coils constructed in this way are given below and are shown in figure 3. All the European stations have been copied in Jersey City, using these coils in connection with an antenna 150 ft. in length and a single vacuum tube.

For wave-lengths from 2,200 to 6,000 meters the diameter of the core should be 2", width of slot ½", depth of slot ½", wound with about 300 turns of No. 10-38 Litzendraht or No. 28 single silk-covered wire.

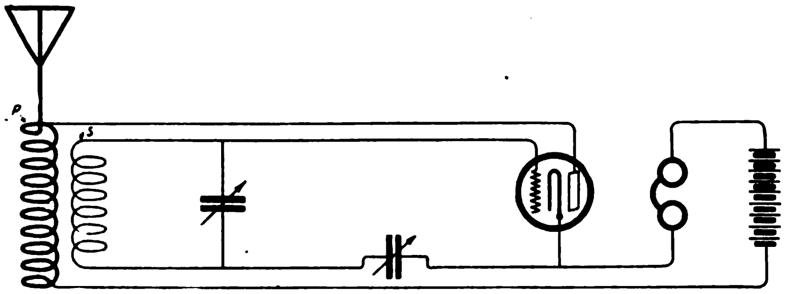


Figure 6—Diagram of a circuit suitable for damped wave reception

For wave-lengths up to 15,000 meters, the diameter of the core should be 3", width of slot ¾", depth of slot ¾", wound with about 2,100 turns of No. 10-38 Litzendraht. In this and the above case, 6.5 mil paper was used between layers.

For receiving, the coils should be placed as shown in figure 4. In the event that the circuit does not oscillate, the position of the tickler coil T as related to the secondary S, should be changed and it may be that the coil should be reversed in the circuit. This same effect may be accomplished by reversing it in its plane. If everything is in proper order, a slight click will be heard when it is dropped from a plane parallel to the plane of the secondary coil to a plane at right angles to the secondary coil. Figure 5 shows another circuit which may be tried and which gives considerable amplification. Here C has a capacity of about .5 microfarad; L an iron core inductance such as the secondary of a telephone transformer. For damped wave reception the circuit shown in figure 6 is convenient.

The coils shown in the photograph were constructed by an amateur, Emil Heydolph, of New York.

A Modern Receiving Set

By L. W. Van Slyck

HAVING designed and operated the receiving set shown in the photo, and since my results were so good in every respect, I am submitting the specifications, believing they might be of interest to readers of THE WIRELESS AGE.

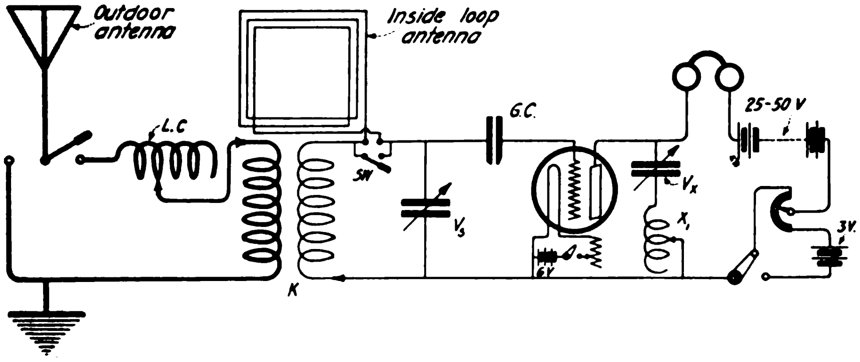
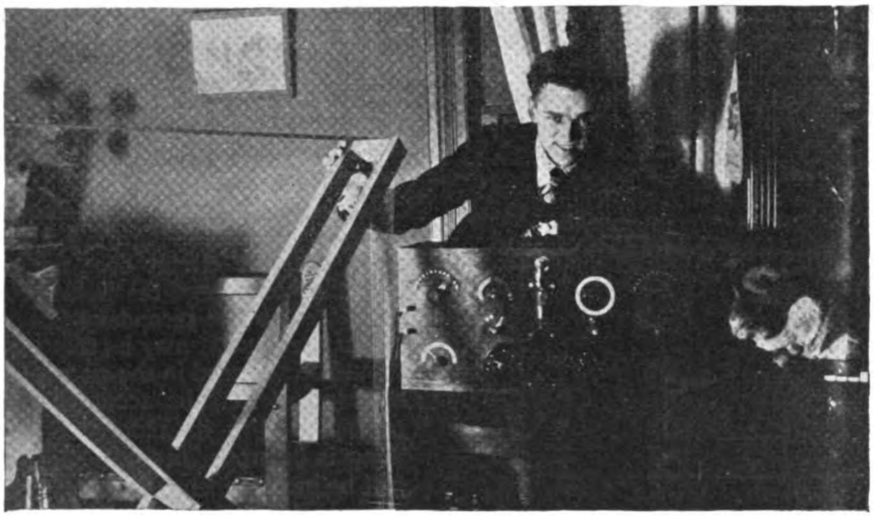


Figure 1—Wiring diagram of circuit used

The "loop" is constructed as shown in figure 2, and can be seen at the left in the photograph. The loading coil and the "X" circuit coil may be made in any required dimensions. For 2,500 meters, I find that a coil 4" in diameter and wound for a length of 10" with No. 24 wire is amply sufficient.

The two variables, Vx and Vs are of .001 and .0005 mfd. capacity, respectively. The loading coil, LC, and the loose coupler K, may be of any design for the range of wave lengths desired. I am using a loading coil similar to the coil X, and about half as long, with a "Blitzen" receiving transformer. The rest of the outfit is, I believe, self-explanatory.

When it is desired to use the loop, open switch SW, turn the secondary



The complete receiving set using a loop antenna

of the receiving transformer to 0° coupling and disconnect the outdoor antenna (if desired). Then tune with Vs and Vx, orientating the loop until signals are a maximum.

With the set described, and using the loop, I find no trouble in copying along the coast from NAH to NAR, and NAT, and the large majority come in plenty loud enough to read.

Using the outdoor antenna with these instruments, the same stations come in about five times as loud, and, of course, many others which are inaudible with the loop. The loop in this form is not highly directive, having a maximum range of orientation for a given signal of approximately 60° without a noticeable change in signal intensity.

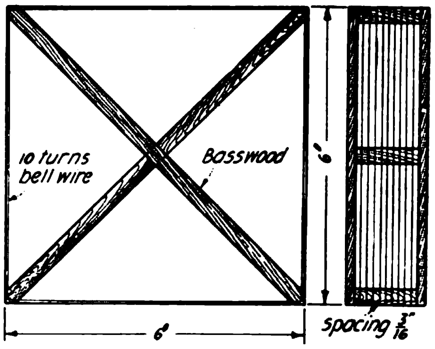


Figure 2—Dimensions and constructional details of the loop

If it is desired that the loop be more directive, it can be wound pancake style.

An Antenna Switch

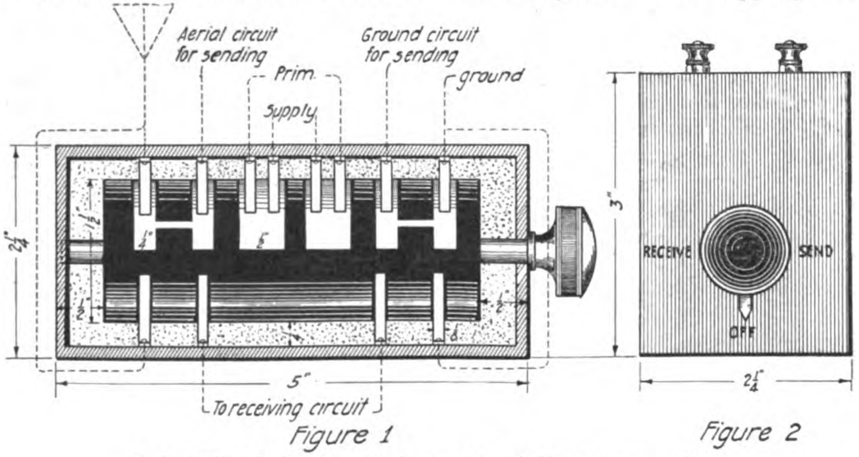
By F. McGuirk

THIS type of antenna switch is somewhat different from the usual ones in use today. It is a rotary type, as will be seen from the diagrams that accompany this article.

Details of the construction follow:

Procure a rubber or dilecto cylinder 4" long and 1½" in diameter, 6 inches of brass strip, ¼" wide and ⅛" thick, and 3 inches of brass ½" wide by ⅛" thick, and about 3 inches of phosphor bronze strip, 1¼" wide and 1/64" thick. The phosphor bronze must be thin enough to have a kink put in it. Some brass rod 5" long and ¼" thick, and two bakelite strips 4½" long each, and ½" wide and ⅛" thick will also be needed. The cabinet and knobs may be constructed to suit the builder.

First, on each end of the cylinder, draw 4 equal right angles. Cut the brass into pieces (both sizes) of 1-5/32" in length. Draw two lines and bend the brass to fit the cylinder. When fitted snugly, place each piece ¼" apart and screw it down. These are put in place between the lines. Next put the rod through the cylinder and thread the ends for bolts to prevent the cylinder from slipping. Now cut the phosphor bronze into strips ⅛" wide. In the one end cut out about ⅜" in the middle to increase the spring and hammer a kink in it similar to the kink in figure 3. Then take the bakelite strips and drill holes of a size to fit the builder's screws or bolts at ½" from either end and in the center of the strip.



Constructional details and dimensions of the antenna switch

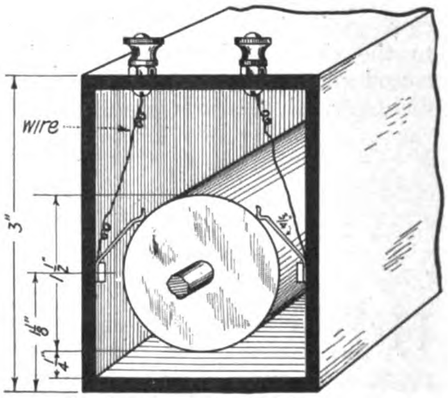


Figure 3—Cut-away view to show method of connecting

The cabinet is very easy to make; the front should be put in place last. The end of the rod should set ⅛" in, as is shown in figure 1. The bakelite strips should be put in place 1⅛" from the bottom and the phosphor bronze strips stuck in and left ¾" out. When the strips are in place and wires are soldered into them the front may be put in place. The strips should be bent until they bear with force on the cylinder itself to make a still better contact on the brass. When the strips are properly in place and function O. K. then connect the wires to the binding posts on the top, labelling everything carefully. The knob may be placed on the previously threaded rod and the lettering on the front.

This makes a switch that can be shut off and on from the operator's table, and prevents the aerial from having a clear path right through the apparatus. The operation is positive and the builder could arrange a spring to make it impossible to leave the switch only half on.

A 60-Watt Low Power Transmitter

By L. R. Felder

FIRST PRIZE, $10.00

THE set described in this paper is one which has actually been built and used by the writer and has given the most satisfactory results. Several important considerations which resulted in the choice of this set may prove interesting to the amateur.

A simple set was desired which would transmit about 25 miles, operate at maximum efficiency without making numerous adjustments, and could be built out of material which every amateur already has. A further consideration was that it should not depend for its operation on peculiar differences in the different items of the set. The set which fills these requirements best is one consisting of a battery operated induction coil, properly designed, actuating a closed circuit directly coupled to the antenna.

While vacuum tube sets are coming more and more into use, the writer did not think it desirable to use one in this case, although he has had considerable experience with tube sets. In the first place, with the tube set, the question of life is an important item. Although the tubes that most amateurs are using are of a very high standard they burn out occasionally, especially when they are used for transmitting. Furthermore, too many tubes would have to be used for the powers desired. For the above power rather high voltages would be required. This either means a high voltage D. C. generator which is quite expensive, or using rectified A. C. which involves the building of a transformer with the required smoothing out circuits, all of which means considerable expense, and requires a good deal more experimenting and fussing to get results than most amateurs imagine. Again the tube set depends to a large extent on the constancy of the different items in the set. Those who have had any experience at all with tube sets know that if for some unknown reason the capacity of the antenna has changed the least bit, the adjustments of the set will have to be changed or the set may not operate at all. In other words, the tube set is too critical for good amateur use. This statement applies to any small change that may occur in any other part of the set.

The set described has none of these defects and is very easily built and does not require a large amount of apparatus. The diagram in figure 3 shows all the apparatus needed, and what the set consists of. It consists of a specially designed induction coil the primary of which is operated by means of a key and 12-volt storage battery. The secondary is connected across two condensers in series, which with the spark gap and inductance form a closed circuit. The inductance is directly coupled to the antenna. As seen in figure 4, the assembly is very simple and the items in the set are reduced to a minimum. When assembled and placed in its case, the whole set occupies a space of about 10 x 6 x 6 inches.

The transformer which has been built for this set, is an unusually good one and is recommended to all. The details of the design and construction are given so that any one may build one without having to go through the whole process of designing it. It is intended to be used with a 12-volt storage battery. The secondary voltage necessary to jump the gap is 7,000 volts. The ratio of transformation is, therefore, 600. The primary consists of 80 turns of No. 20 D.C.C. wire wound in 1½ layer along a length of 3 inches. The primary is wound directly on the core. The core is made up of silicon steel strips No. 29 gauge; this is, 0.014 inches, 3¾ inches long. The strips are tied together by linen tape and when built up, occupy a space ½ x ½ x 3¾ inches.

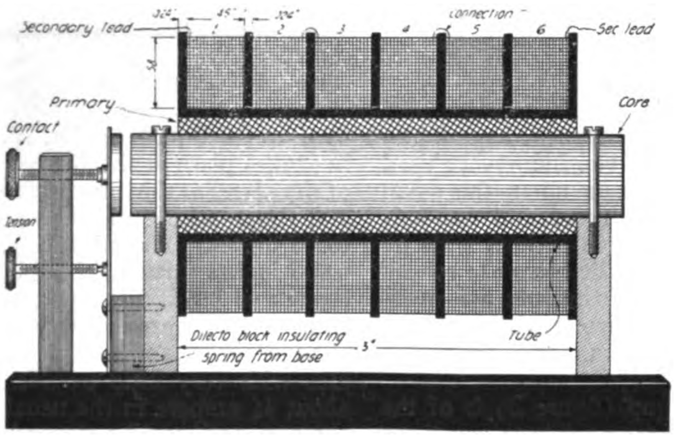


Figure 1—Assembly of the induction coil used in the 60-watt low-power transmitter

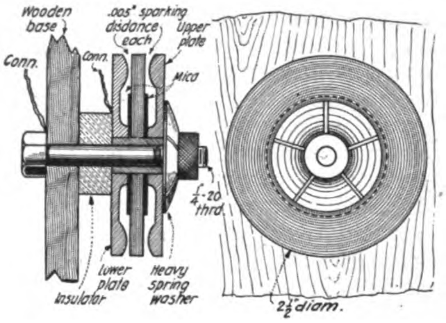


Figure 2—Detailed side and end views of the quenched spark gap

The secondary is wound on a tube ⅞ inch inside diameter and 1⅛ inches outside diameter. The tube is made of paper rolled on a mandrel of the proper size. The paper is thoroughly shellacked and allowed to dry well. The secondary is then wound on the tube. The secondary consists of 6 pies, with 8000 turns per pie, total number of turns being 48,000. The size of the wire is No. 40 enameled. Each pie is 0.45 inches long and has 130 turns per layer, with 61½ layers. The insulation between layers is paper about 0.005 inches thick and about 0.45 inches wide. The pies are insulated from each other by fish paper 0.020 inches thick, 1⅛ inches inside diameter and 1.725 inches outside diameter. In winding the pies it was found that the most convenient way of winding them without running into trouble due to high potential leads crossing low potential leads, was as follows: Wind coils, 1, 3, 5, as shown in figure 1. Then turn winding form around and wind coils 2, 4, 6, always starting at the bottom left. Then solder connection as shown so that one continuous winding is formed. The whole winding should then be covered with one wrapping of bookbinder's cloth.

The assembly of the transformer is seen in figure 1. The base is made of cast aluminum about ¼ inch thick. The spring is made of spring steel, and the armature which is riveted to the spring is made of soft iron. The contacts are silver ⅛ inch in diameter. There are two screw adjustments which are made of brass. The upper screw adjusts the spacing of the contacts and the lower adjusts the tension of the spring. As indicated in the diagram, the spring is insulated from the base by a dilecto spacer.

There are two condensers across the secondary of the induction coil. The object of the two condensers is to prevent possible breakdown and to provide ample capacity over which to distribute the potential. One condenser can of course be built to withstand the voltage generated across the secondary. Each condenser has a capacity of 0.005 mf., the total effective capacity being 0.0025 mf. The size of these condensers can be very easily figured by the usual conventional formulas and is therefore not given here. It is advised that 2 mil mica be used.

The voltage which is built up across the terminals of the condensers discharges through a quenched spark gap and inductance. The inductance used is a flat spiral made up in the usual way. There are three and one-half turns of copper strip ¼ inch wide by 1/32 inch thick. The turns are spaced ¼ inch. The adjustments are made for the proper wavelength by taking taps off the spiral, as shown in figure 3.

The spark gap (figure 2) is of the quenched gap type. There are three plates forming two gaps. The plates are made of ¼ inch brass or copper silver plated. Each of the plates has a clearance hole of ½ inch so that the ¼ inch screw running through the plates does not short-circuit any of the sections. The upper and lower plates both rest on the center plate but are insulated from each other in the center by mica 0.005 inches thick. The sparking takes place at the formed portions of the plates at the outer circumference and the sparking distance per gap is 0.005 inches. The mica insulators are 0.005 inches thick, ¼ inch inside diameter and 1½ inches outside diameter.

The set has proved very successful, is very simple to construct and operates with very little trouble. It puts about ¾ ampere in the usual amateur antenna and can be depended on to send at least 25 miles.

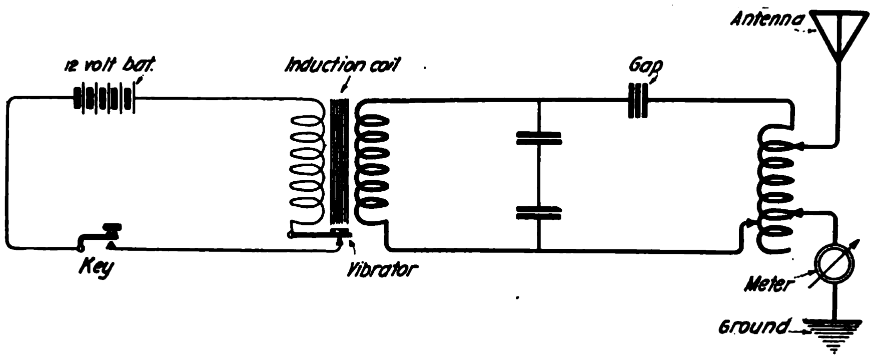


Figure 3—Diagram showing hook-up of instruments

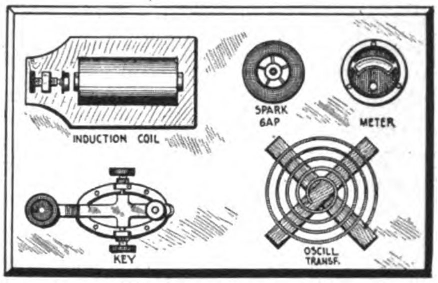


Figure 4—Panel arrangement of instruments

The Design and Construction of a Low Power Transmitter for Local Use

By Walter A. Remy

SECOND PRIZE, $5.00

AS operator of 2KV the writer has noticed that in the past two months QRM has again reached the same stage as it did in 1917. It is impossible to do any long distance amateur receiving or relay work until after 10 or 10:30 p. m.

This is not alone due to the spark coil—which has been blamed for interference to such an extent that it is looked upon as a thing only capable of causing QRM—but also the big transformer station. The writer, in fact, has experienced more trouble with the latter than with the spark coil. More than once two stations 5 or 6 miles apart have been heard working with ½ kw. power on each end, and in some cases even 1 kw.

The Government Station License says that only the minimum amount of power necessary to carry on communication should be used. It is the purpose of this article to describe the construction of a spark coil transmitter which serves the double purpose of reforming the spark coil and of providing a transmitter which can be used by the big stations for local work.

Let us first consider the technical aspects of a low power transmitter. There are two types, namely, the vacuum tube or continuous wave transmitter, and the spark coil set. The vacuum tube set has the advantage of having little or no decrement and therefore produces a very sharp wave, causing practically no QRM. On the other hand, the initial expense of this type of transmitter makes it prohibitive for general use, for the builder must purchase the tubes and solve the financial problem of supplying the plate voltage. There are two types of spark

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coil sets. The one in which a commutator interrupter is used in the primary circuit and a synchronous rotary gap in the secondary circuit is exceedingly efficient, but for economic and constructional reasons this, too, is impractical for general use. Hence, we have left the conventional type of spark coil transmitter with a vibrator and a fixed gap.

The panel type set which is described in this article has been constructed and is in daily use at the writer's station; it is quite efficient, and with 6 watts input on exactly 200 meters, signals from this station have been heard at a distance of 25 miles. Sixteen miles is the consistent working range—ample enough for local work.

The set mainly consists of a spark coil (a Ford ignition coil was used), a fixed spark gap, condenser, and pancake type helix.

The front view of the panel is shown in figure 1. This panel may be of bakelite, asbestos, or hard wood, and is 10" x 16" in width and length, respectively. A small DPST switch is used to connect the power to the set. Above this is the spark gap, and then comes the hot wire ammeter, which is of small scale, with the shunt switch to "short" it when it is not in use.

The side view (figure 2), shows the general layout of the apparatus. The spark coil is mounted on the condenser, and may be of ½" to 2" rating. It is not recommended that the spark coil be built, as it requires a considerable

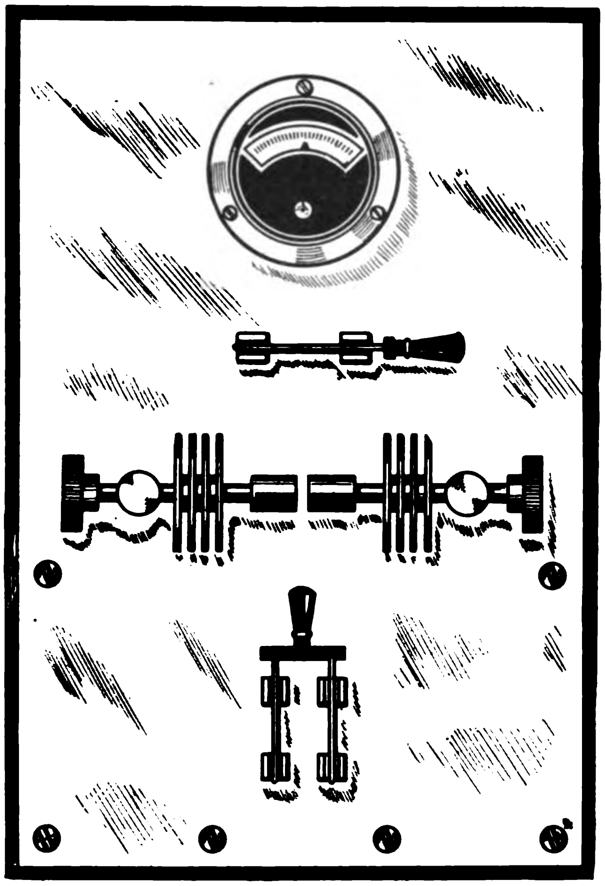
Figure 1—Front view of panel

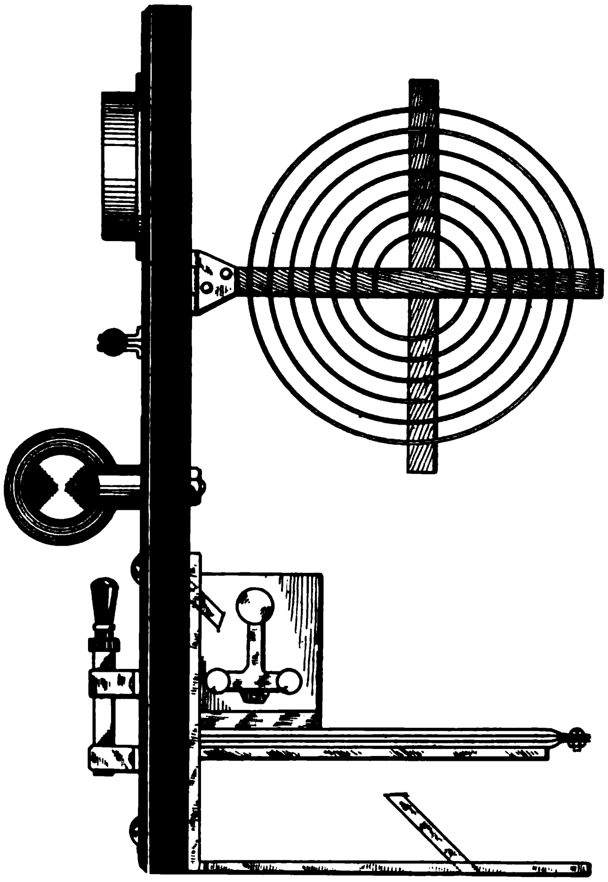
Figure 2—Side view showing layout of apparatus

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amount of labor to construct one and the expense will not be much less than the manufacturers' selling price.

The spark gap may be purchased or constructed, as the builder may desire. It is mounted on the panel and should have sparking electrodes at least ⅜" or ½" in diameter, depending upon the power of the set. Four cooling fins 1½" in diameter should be provided on each electrode and should be of brass. This offers a large amount of surface which dissipates the heat and keeps the gap cool, making it more efficient.

The condenser consists of three glass plates 4" by 6", coated on either side with tin-foil 3" x 5", connected in parallel. Lugs ¾" x 1½" must be included in each tinfoil conductor. This condenser is mounted on a piece of bakelite or hard wood of the same dimensions as the condenser, fastened to the panel by means of angle brackets, or it may be placed directly on the operating table. Another piece of bakelite or hard wood about the same size as the base of the spark coil is placed on top of the condenser, upon which the coil is mounted. These pieces insulate the condenser from the other parts of the transmitter.

The helix was chosen in preference to the oscillation transformer, after a little experimenting which showed that there was too much loss between the primary and secondary. The wave emitted when the oscillation transformer was used was sharper, but with the helix in use the emitted wave was sharp enough for all practical purposes, and there was a greater radiation. And again, the helix was used on most of the army's low power spark sets during the war. The helix is wound on two cross-pieces 9" long by ½" square. On the supports were wound 9 turns of ½" copper ribbon spaced ⅜" apart. When making the grooves for the ribbon, remember to begin in the first notch on each arm ⅛" further from the end than the preceding arm, so as to form a perfect spiral. The first notch of the first arm is cut ¼" from the end, the first notch of the second arm ⅜" from the end, and so on. Each notch should be ⅜" deep. The helix is then mounted at right angles to the panel by an angle bracket. It will be noted that the various instruments are close together and the leads will be very short.

The conventional transmitter circuit is shown in figure 3. For greatest efficiency the leads should be of braided copper ribbon, which has a large conducting surface and is quite flexible.

In conclusion, it might be well to note several points in adjusting this transmitter. No one must expect to get the results mentioned in the first part of the article without the use of a wavemeter and, of course, the hot wire meter. As the use of the wavemeter is taken up at length in various text books nothing will be said about its use here. Another point to keep in mind is the vibrator of the spark coil. As long as the vibrator is kept bright and clean the set will have a smooth note, but the minute it is allowed to become pitted or dirty, the note will be scratchy and will lessen the efficiency of the set and also the popularity of its owner. If the builder follows the directions in this article with some amount of care, and he has a good aerial, there is no reason why the performances set forth here cannot be duplicated, as the second district is not especially noted for excellent radio conditions.

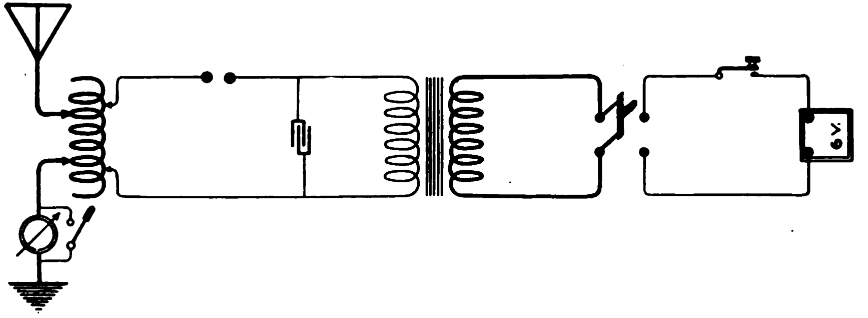

Figure 3—Diagram of the transmitter circuit

Low Power Transmitter for Local Use

By Louis S. Butler

THIRD PRIZE, $3.00

I HAVE used several types of low power transmitting sets, but the one here described has been found the most efficient. To get the proper wave length, together with good results, the aerial should be one of four wires between 40 and 50 feet long, and should be at least 40 feet high. The oscillation transformer is the well-known Murdock hinge type. Any good spark gap is sufficient. The condenser may consist of four Leyden jars, or any good glass plate condenser designed for use with spark coil sets. For power, a 1" spark coil made for radio use is sufficient. The spark coil can be run on six dry cells with very good results, but when run on a 110 v. light line, with an electrolite interrupter, the range of the set can be increased about 10 miles.

I have found this type of low power transmitter to be very efficient for sending strong and clear signals from 20 to 30 miles in the day time, the receiving station using a vacuum tube, but no amplifiers. Of course the experimenter must bear in mind that to get the very best results from his set he must have a good aerial and good ground, and he must have as many connections soldered as possible. The set here described when *properly tuned* is very efficient for local work, and due to its very moderate cost will be found within the reach of most every amateur. A 25 watt 110 v. lamp in series with the antenna will be found suitable for determining the antenna radiation where a hot wire ammeter is not available. The great advantage of this set is that it can be tuned sharply so as to cause small interference, which will be greatly appreciated by other operators.

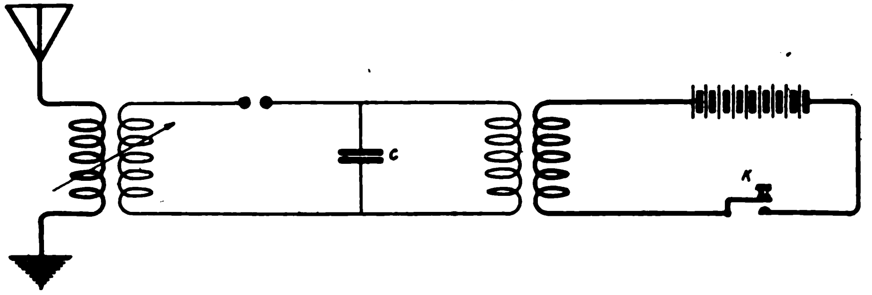

Figure 1—Diagram of circuit for the low-power transmitter

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A Useful Switch Arrangement

SOMETIME ago I had occasion to build a single unit receiving set, having regenerative features and one-step amplifier. The diagram shows how a single anti-capacity jack switch was used to throw in the audio-frequency amplifier.

Starting at the aerial: the primary of a loose coupler is shown, also a switch for putting the primary condenser either in series with ground lead or shunt to the primary inductance.

The secondary of the coupler has the ordinary detector hook-up when the tickler coil is short-circuited.

When the tickler coil is not shorted, you have the regenerative feed back circuit. Now, when the master jack switch (anti-capacity) is thrown to the left, you have a regular detector hook-up or a regenerative hook-up,

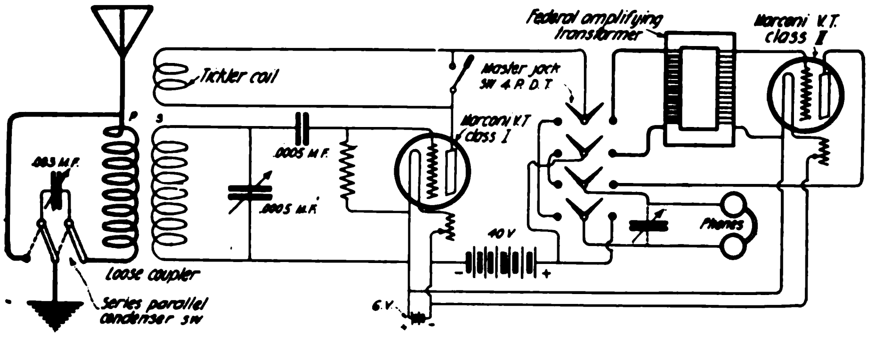

Diagram of single unit receiver having regenerative feature and single step amplifier

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depending upon whether the tickler is short circuited or not.

When the master jack switch is thrown to the right, the single-stage audio frequency amplifier is connected in circuit.

The advantages of a hook-up of this sort are as follows:

1. All instruments can be mounted on a single panel.
2. Detector hook-up alone can be used.
3. Regenerative hook-up alone can be used.
4. Detector and single-stage amplifier can be used.
5. Regenerative and single-stage amplifier can be used.
6. All these combinations are effected by the throwing of only two switches, namely, the master jack switch and the tickler short circuit switch.
7. Also a single "A" and "B" battery are used.

I have given no dimensions, leaving it entirely up to the amateur desiring a compact flexible receiving set.

The popular "honeycomb" coils may be used for loose coupler and tickler coil.

VINCENT H. BROWN.

A Small Portable Set

By William Holladay

SOME time ago I became interested in a very small set I saw illustrated, for which a wave-length of 4,000 meters was claimed. It was about six inches long and three or four inches high and wide, but at the beginning it was apparent that there were several inherent defects. The coupler was wound with 36 enameled wire, the high resistance of which, coupled with the well-known distributed capacity effects of enameled wire, cut the efficiency down to minimum. The coupling was fixed, and therefore would have to be designed very carefully in order to have the coupling at the proper point for the larger percentage of stations. Of course all stations which are received with very loose or very close couplings would be heard more faintly than necessary, and selectivity would be almost impossible.

The detector was placed on top of the set, where it would be exposed to dust and hard knocks, and could not, therefore, be used for portable purposes.

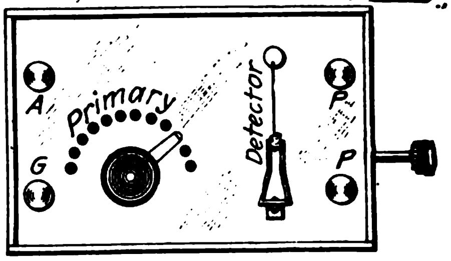

FIGURE 1
Front view of cabinet

A small set designed and constructed by the writer seemed to offer all the advantages of a portable set, with none of the disadvantages referred to above. It is an excellent thing to take along on a vacation jaunt, and may be made

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mostly of materials at hand in the workshop.

The set consists of a coupler, galena detector, and fixed condenser, mounted in a cabinet 6 x 5½ x 4. The primary tube is 3" long and 3" in diameter, wound with about 130 turns D.C.C. With silk covered wire it is possible, of course, to wind more turns, but on such a set I believe the extra cost overshadows the benefits. The secondary is 2½" long and 2½" in diameter, wound with 110 turns 32 D.C.C. Such a secondary will respond to wavelengths up to approximately 1200 meters with a 200 meter aerial. The resistance of the wires used is only slightly greater than that of the usual sizes, and the efficiency on the short waves which it will receive is not materially lowered. The primary is tapped to a single twelve-point switch, and the secondary is tapped to a single four-point switch as per the diagram.

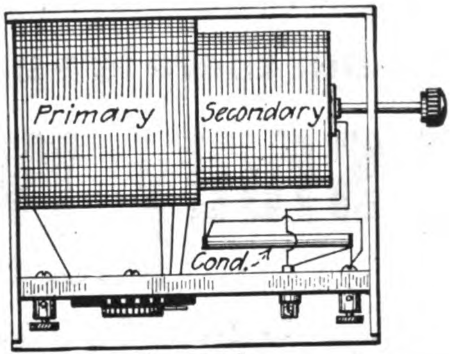

FIGURE 2

Top elevation showing arrangement of apparatus

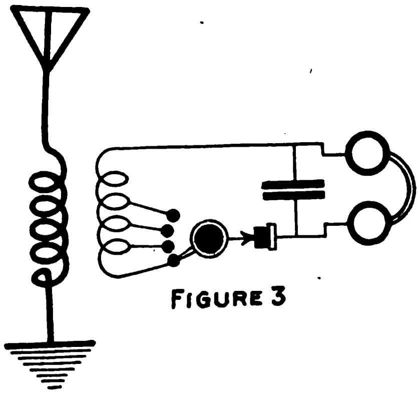

FIGURE 3

Diagram of connections used

The cabinet may be made of cigarbox wood, or if more strength is desired, of ⅜" pine or hardwood. The front is hinged over the panel, which is set back about an inch for protection of the detector and primary switch, which are to the right and left respectively. Excellent switch points may be made of 6 B. & S. copper ¾" long which are driven into holes 5/32" diameter, and spaced ¼" apart. The switch arm is made 1" long so that the entire switch will occupy but little space.

The detector, placed to the right, consists simply of a phosphor bronze spring or clip to hold the crystal, and a catwhisker of 32 bare copper. Connections, soldered to the rear, are made with small stranded wire. Four Clapp-Eastham 4832 binding posts, the smallest manufactured, are provided for aerial, ground and phones. They are mounted on opposite ends of the panel.

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The diagrams show front and top elevations of the cabinet, the arrangement of instruments, and connections.

Convention in Philadelphia

AMATEURS of the Third District are invited to attend a convention and banquet to be held under the auspices of the Philadelphia Amateur Radio Association, in Philadelphia on May 8th.

This convention is intended to strengthen the bonds between the amateurs in the Eastern part of the country and give them a good time while they are meeting the men who handle the three sets. It is proposed to arrange a program for the summer and fall for all amateurs to meet the men they have talked to through the ether. There will be good talkers, plenty of good eats, smokes, music and a rip roaring good time for all who attend. Tickets are $2.00, the big show is called for 7 P.M. at 12th and Girard Avenue, Philadelphia, Saturday, May 8th. Club secretaries are invited to write how many members they will send. Address W. F. Wunder, 3220 Stillman St., Philadelphia.

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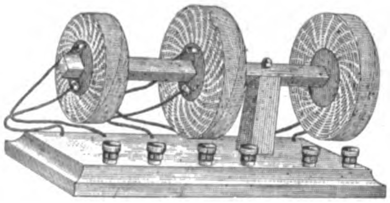

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Prize Contest Announcement

The subject for the new prize contest of our year-round series is:

"Operating Suggestions for the Radio Amateur."

Closing date, June 1, 1920.

Contestants are requested to submit articles at the earliest practicable date.

Prize Winning Articles Will Appear in the August Issue.

It is very obvious to those who are listening-in a great deal that a great percentage of the amateurs who operate transmitting stations either have never carefully thought about the interference problem, or have no regard whatsoever for their co-workers in the next block, the next city, or the next state. This may be particularly true of the young man who is just taking up the art, and it is with him in mind that we call for suggestions covering the use of the code, calling, handling messages, listening-in, etc., etc. There are a great many amateur operators who have this traffic business down to a fine art. This will give these men an opportunity to very materially help their co-workers and indirectly benefit themselves.

PRIZE CONTEST CONDITIONS—Manuscripts on the subject announced above are judged by the Editors of THE WIRELESS AGE from the viewpoint of the ingeniousness of the idea presented, its practicability and general utility, originality, and clearness in the description. Literary ability is not needed, but neatness in manuscript and drawing is taken into account. Finished drawings are not required, sketches will do. The contest is open to everybody. The closing date is given in the above announcement. THE WIRELESS AGE will award the following prizes: First Prize, $10.00; Second Prize, $5.00; Third Prize, $3.00, *in addition to the regular space rates paid for technical articles.*

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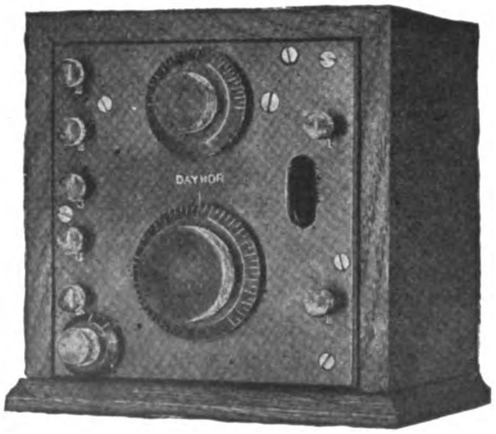

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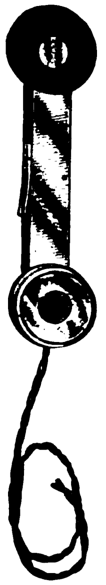

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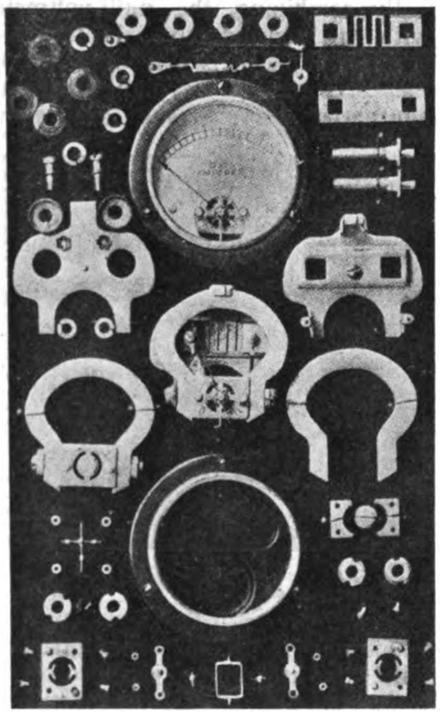

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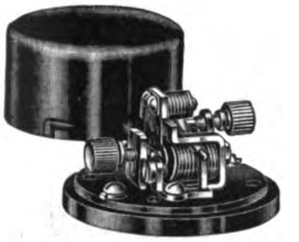

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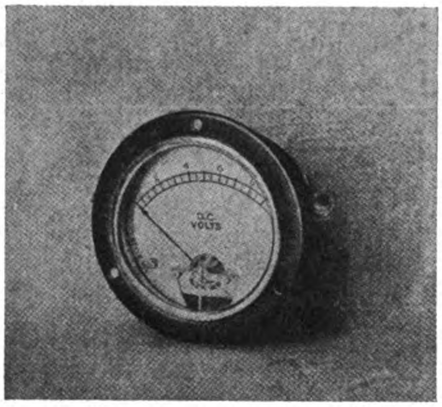

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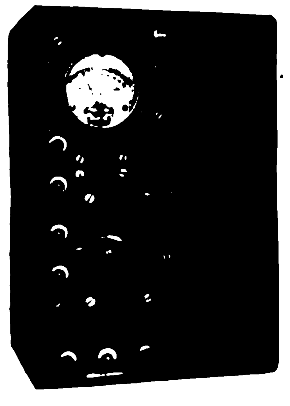

Realizing the great and growing need of a single supply house that could furnish instantaneously all radio apparatus, the National Radio Supply Company comes to you with a message that will appeal to all that have a want in radio apparatus to supply. On April 15, 1919, our concern represented and was authorized sales agency for 40 different concerns. Today 91 of America's foremost wireless firms have placed their apparatus and sales agency with us. Think of the convenience this means to you. You get just what you want in the radio line just when you want it.

Ten cents in stamps will bring you our 74 page catalog No. 2 which shows more approved, dependable radio apparatus than any other similar book ever published by any concern outside of the National Radio Supply Company. To those who already have this wonderful catalog, the new price bulletin issued monthly will be forwarded upon request for same. Our supply of the above becomes obsolete after April 15th as this issue will be entirely exhausted.

SPECIAL NOTICE TO AMATEURS, radio concerns and schools: Our new catalog will be ready for distribution May 1, 1920, consisting of 125 pages of the most interesting display of radio apparatus ever published in any catalog. In addition to the display of radio apparatus, this catalog will contain 75 hook-ups, one page showing radio symbols used extensively by all radio manufacturers. Prompt shipments will be made on any of the apparatus listed in this catalog; and while it is impossible to list every piece of apparatus that we handle, a postal card will bring you prices on any other apparatus not listed in our catalog.

Fifteen cents in stamps will bring this new catalog to your door. The hook-ups alone will be worth many times the price.

Let our radio expert answer your questions without charge. Advice given to those who contemplate putting in a wireless set; stamped, addressed envelope must be included with your inquiry.

NATIONAL RADIO SUPPLY CO., "The Nation's Clearing House," Dept. 124, 808 9th St., N. W., Washington, D. C.

Our storeroom displays several thousand dollars in radio apparatus. When in Washington, we cordially invite you to visit our store and look over our line. Direct outlet for the South.

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110 VOLTS, D.C. or A.C.
It is absolutely complete as shown. Needs no helix, spark gap, condensers, etc., etc. Simply connect to aerial, ground and electric circuit, and send.
NO BATTERY EXPENSE
Runs all day for 2 cents
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PRICE $18.00 COMPLETE
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ing on direct current and radio frequency current of the frequencies now in use.

These instruments are the smallest of the D'Arsonval type that are being regularly manufactured.

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WHY is it that high-voltage condensers using oil as a dielectric have never become popular for amateur stations? Such condensers are self-restoring, even if punctured; the dielectric absorption is low, comparing favorably with compressed air and many times better than bakelite, where this loss is very troublesome and brush discharge is entirely absent. Also the construction is simple and rugged, involving only a little machine work in making the spacers. In all respects this condenser is nearly ideal. Sheet aluminum was used for the plates of the condenser which I constructed. Number 30 sheeting, which has about seven square feet to the pound, is the most satisfactory. About 3½ pounds are required. This was cut into 28 pieces 12" by 10", which are required for a capacity of .008 mfd., and a 3/16" hole was drilled in each corner. For separating alternate plates, 112 spacers are required, ⅜" long, each cut from ¼" brass tubing, with 3/16" inside diameter. The plates are mounted on supporting rods 6½" long, 3/16" in diameter, and threaded ½" on each

Q. S. T.

Radio experimenters buying through this association are purchasing the goods of every advertiser in this magazine at considerable saving. We fill orders the day they arrive. After deducting their membership discounts they obtain the following prices:

22 V "B" Batteries	$1.10
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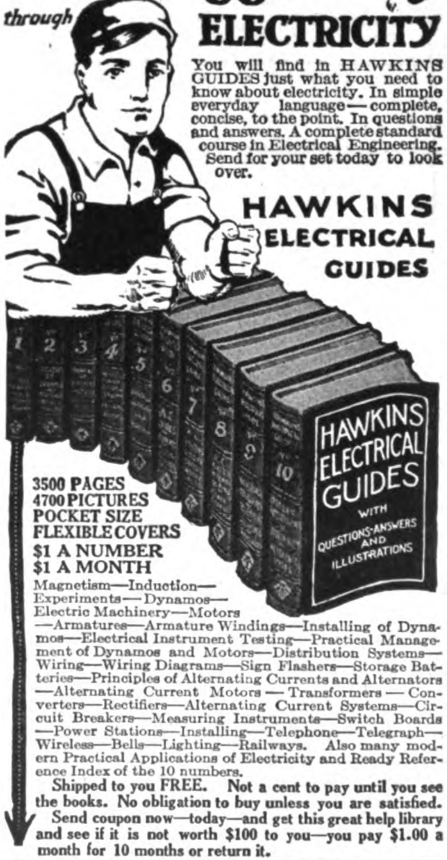
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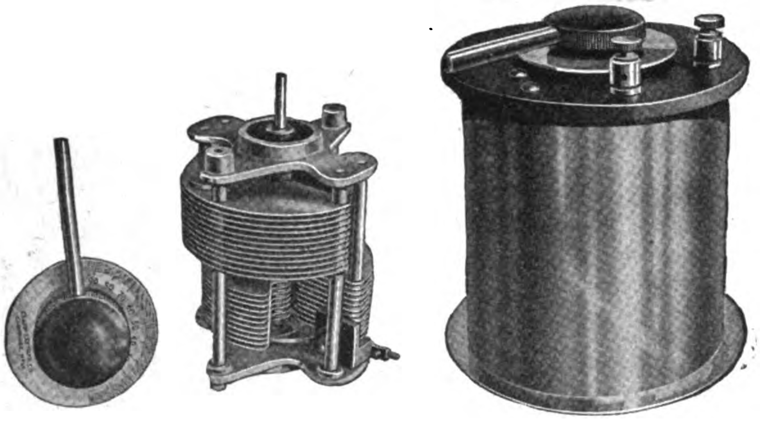

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Watch this magazine for future advertisements containing our big offers.

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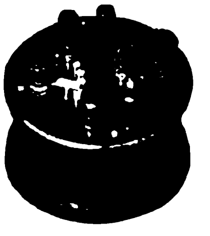

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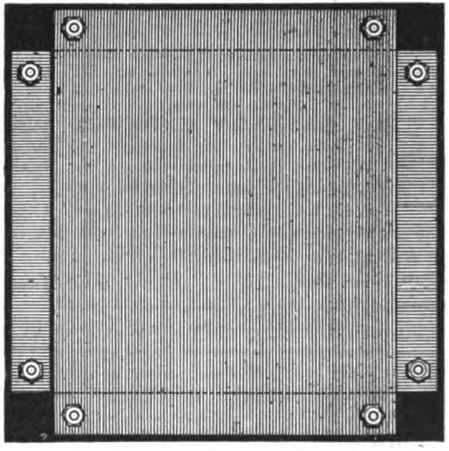
end. Eight of these rods are required. The whole condenser was then assembled on a hardwood base 12" square, as shown in the accompanying drawing, the plates being alternated, and four 3/16" spacers being placed under the first plate.

From the foregoing it will be seen that alternate plates are spaced 3/16". The best grade transil oil on the market such as "Mineral Seal" or "High-flash," should be used for the dielectric, this grade withstanding 36,000 volts on a 1-10" gap, so that the spacing of 3/16" gives a margin of safety sufficient for all ordinary purposes. The oil should be tested by dropping some pieces of calcium carbide into a sample taken from the bottom of the container, and if bubbles are given off, it indicates that water is present, which *must* be removed.



Assembly of condenser plates and base

This is accomplished by filtering the oil through calcium chloride several times, and then through several thicknesses of cheese cloth. The oil should then be tested again with carbide. The dielectric constant of this grade of oil is about 2.5, which compares favorably with glass and does not require an excessive area of the plates.

The entire condenser should be placed in an oil-tight container with a cover to keep out the dust. A galvanized tank into which the condenser is placed edgewise will be found very satisfactory, using a top piece of bakelite for a cover and as a terminal mounting. Such a condenser as this will repay any amateur in the satisfaction of knowing that it is both efficient and permanent, and the cost is but a fraction of some of the commercial condensers on the market.

Learn for Yourself

IT HAS often occurred to us that there are a great many amateurs who, rather than provide themselves with the means of finding out things for themselves, will either blissfully go along in ignorance without daily improvement in their knowledge of radio, or who when they desire to know something or other concerning the action of a circuit or concerning constructional details, will depend upon the knowledge of their friends or the help which the editors of the radio publications are able to give them.

Has it ever occurred to the man who experiments with radio that his first requisite should be a thorough knowledge of the textbooks on the subject? For the beginner, perhaps the best book available is Bucher's "Practical Wireless Telegraphy." For the man who is a little more advanced, serious study of Bulletin No. 74 of the Bureau of Standards, "Radio Instruments and Measurements" is recommended.

Queries Answered

Answers will be given in this department to questions of subscribers, covering the full range of wireless subjects, but only those which relate to the technical phases of the art and which are of general interest to readers will be published here. The subscriber's name and address must be given in all letters and only one side of the paper written on; where diagrams are necessary they must be on a separate sheet and drawn with India ink. Not more than five questions of one reader can be answered in the same issue. To receive attention these rules must be rigidly observed.

Positively no Questions Answered by Mail.

G. N. G., New Jersey:

The natural wave length of an antenna can be approximated by the use of formula for the capacity and distributed inductance of the wire. Results obtained thus are almost invariably lacking in accuracy. The fundamental should be ascertained by measurement, if at all possible, and we refer you to textbooks on the subject. A rule for the predetermination of the fundamental of an antenna within limits which compare favorably with those of any formula available, calls for the multiplication of the length of the antenna in feet by 1.52 where the antenna is the L of the type used by a great many amateurs, and by 1.6 where the antenna is a T, or fan, type. Thus your antenna, height 35 feet, length 36 feet, total length 71 feet, will have a fundamental of about 108 meters, when used as an L. As a T, whose height is 35 feet and length 18 feet, total length 53 feet, the fundamental would fall around 85 meters.

* * *

W. F., Alabama:

Any type of three-element vacuum tube may be used in a resistance coupled amplifier circuit. If you desire to use only two tubes, your over-all amplification will be greater, providing a transformer is used between the two. Resistance coupled amplifiers are used to greatest advantage where several stages are essential, due to its greater stability and freedom from self-oscillation.

* * *

D. R., Wisconsin:

We are sorry to report that we know nothing concerning the detector you mention. The filament of a Marconi V. T. should draw between 0.7 and 0.8 of an ampere, at which current the filament is incandescent. Noises in the telephones when the tube is in operation may be occasioned by gassing of the storage cell, a faulty cell in the plate battery, a loose connection in the circuit, a loose connection in the tube itself, or may be due to the presence of gas within the tube, under which circumstances a hissing sound will be given off when either the filament is too bright or when the plate potential is a little too high.

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The Grebe Special Type CR-3 Relay Receiver

Unparalleled performance on Relay wavelengths.

Constructed according to the highest engineering and manufacturing standards.

This Instrument was fully described in Q S T for March, 1920 and may be found on display by the following concerns:

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Undamped Wave Receptors

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Strongest, Most Distinct Signals

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Price $13.00

These head receivers are the exact type used by the Army and Navy wireless operators during the war. The Signal Corps U. S. A. knew them as #P-11. The U. S. Navy knew them as C-W 834.

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110-220 volts, A. C., 60 cycle, 1800 R. P. M. with pulley

1/4	H. P., 110 volts, induction, full load start - -	$24.50
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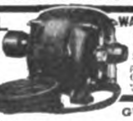

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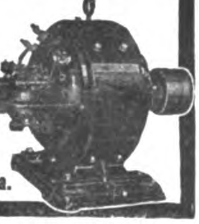

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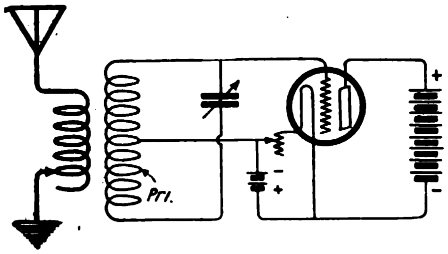
A .001 mfd. condenser placed in shunt to the telephones will give you the same louder signals which you received from Arlington when you placed your fingers across the terminals. There is a tendency for radio frequency currents to build up in the plate circuit of the vacuum tube. The telephones will not pass them to any great extent. If a path is provided they will be repeated back into the grid circuit to a limited degree, solely by virtue of the filament circuit connections which are common to both plate and grid circuit. This results in increased amplifying action, or regeneration, on the part of the tube, and can be taken full advantage of only when the coupling between the two circuits is sufficient to start self-oscillations in the vacuum tube circuits. If you are not using a regenerative circuit by intent, you should be, and we refer you to textbooks on the subject. If you are using a regenerative circuit bear in mind that a bridging condenser for the telephones is essential for anything like proper action. If you are receiving Arlington—and it should be possible for you to do so consistently—you should also be able to receive Great Lakes. Perhaps you have not properly tuned your receiver. His wave length is 1,512 meters.

* * *

A. L. H., New Hampshire:

A hook-up suitable for the outfit described in the November, 1919, issue by Mr. Pignone is given herewith.



J. A., Porto Rico:

If you are having trouble in adjusting your detector from your test buzzer, we suggest that you try—instead of your present arrangement—the arrangement where a wire is connected to the vibrator of the buzzer, carried to one of the leads from the secondary inductance coil and wrapped around this lead 6 or 8 times, on top of the insulation.

If you are using a variable condenser on the secondary of your receiving transformer, the secondary will tune up to about 15,000 meters. The primary, taken in conjunction with your antenna alone, will only tune up to about 6,500 meters. You may increase the wave length of your primary by shunting a variable condenser across the inductance.

The fundamental wave length of your antenna is about 230 meters. The fact that you connect two receivers on the same antenna and hear signals from a certain station through both of them is not unusual. The signal in either will be greater, however, when the other is disconnected.

As far as we know, it is not the practice under any circumstances to short circuit the secondary tuning condenser. This is often done in the case of the *antenna* tuning condenser where the condenser is connected in series to the antenna, and we presume that it is to this arrangement you refer.

* * *

H. G. G., Pennsylvania:

We presume that by "collapsible aerial" you refer to the loop antennae which were used to such a great extent during the recent war for direction finder purposes and also in the trenches. If so, you will find in recent numbers of this magazine instructions and data which will enable you to construct what you wish.

Or perhaps you were referring to an antenna which is collapsible in the true sense. Such an arrangement has never been used to our knowledge for practical purposes. A two and four wire aerial fills the requirements in every way and is considerably cheaper and more nearly fool-proof. We suggest that you use the latter.

* * *

R. R. W., Pennsylvania:
Any dealer in general hardware and supplies should be able to furnish you with 1½" O. D. fibre tubing. If you are unable to make connections with anyone in your vicinity, we suggest that you write Patterson Bros., Park Row, New York City.

* * *

F. V. B., Alabama:
Any effort to control small movable objects on a table by a radio station concealed in the vicinity becomes a rather complicated matter. This can be done in a very simple manner magnetically, provided there is a movable magnet underneath the table of sufficient strength to control the small steel objects above. To do this by radio would necessitate the use of a radio controlled power unit mounted in the small object which it was desired to move, and, taken as a whole, we consider the idea impracticable.

* * *

W. D. M., Michigan:
After reading your query referring to the diagrams in "Practical Wireless Telegraphy" which you mention, we are unable to understand just what you are driving at, unless it is a combination of the circuit shown by Mr. Bremer in the May, 1919, issue, and some of the magnetically coupled regenerative circuits shown in figures 179 and 181 of "Practical Wireless Telegraphy." There would be no advantage in such an arrangement, since the accomplishments of the one are the same as the other.

* * *

A. S. B., Connecticut:
We are not aware of any "Impact System" which operates without transformers. We presume that you have in some way received the wrong impression as to the operation of an impact transmitter. For particulars as to operation of this type, we refer you to any up-to-date textbook on radio telegraphy.

* * *

R. S. T., California:
If you have followed the instructions covering the long wave receiver in the September issue of THE WIRELESS AGE, and providing all your connections are as shown in the diagram, there is no reason why you should fail to get operation. Are you certain that the positive terminal of your plate battery is connected to the plate? With reference to the latter part of the last paragraph on page 36 of this article, the author states: "Any failure of oscillations to start may be due to an incorrect value of bridging condenser, antenna coupling, tickler coupling, filament current, and plate potential, assuming, of course, that the receiver is properly wired." In addition to this, as just mentioned, it is necessary to have the positive terminal of the plate battery connected to the plate of the tube. The fact that you used No. 31 wire instead of No. 22 will not affect the operation of the outfit; only the wave length range, which will have been slightly increased.

It is impracticable to make up a set of this type for operation over shorter wave lengths, with the expectation of getting *best* results. In case you wish to do so, however, you should provide yourself with a secondary coil having about 130 turns, and wound on a form 3" in diameter, 10 turns per layer. The primary coil may be a duplicate of this, taps being taken out to accommodate the switch.

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I understand that I will receive membership certificate pin, pennant and a copy each of "How to Conduct a Radio Club" and "How to Pass U. S. Govt. Wireless License Examinations," and that the yearly dues entitle me to a year's subscription to THE WIRELESS AGE.

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I am now a subscriber to the AGE.

Name ....Age ......
St. Add. ....
City ....State ....

FILL IN ANSWERS TO THESE QUESTIONS

1. Have you a Government License (give number......) or do you propose applying for one?..
2. If you are under 21 years of age, give names of 2 adults for reference as to character:
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3. If you are a member of any Local, State or Interstate wireless club or association give its name and name of Secretary with address
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4. Are you now a subscriber to THE WIRELESS AGE?..................
5. Describe briefly your equipment..
   ....
   ....

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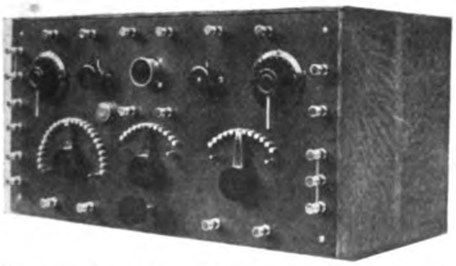

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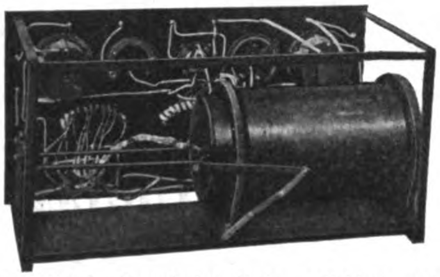

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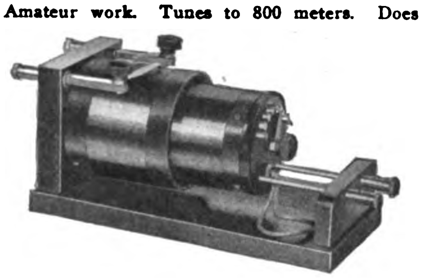

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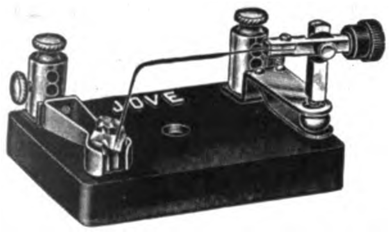

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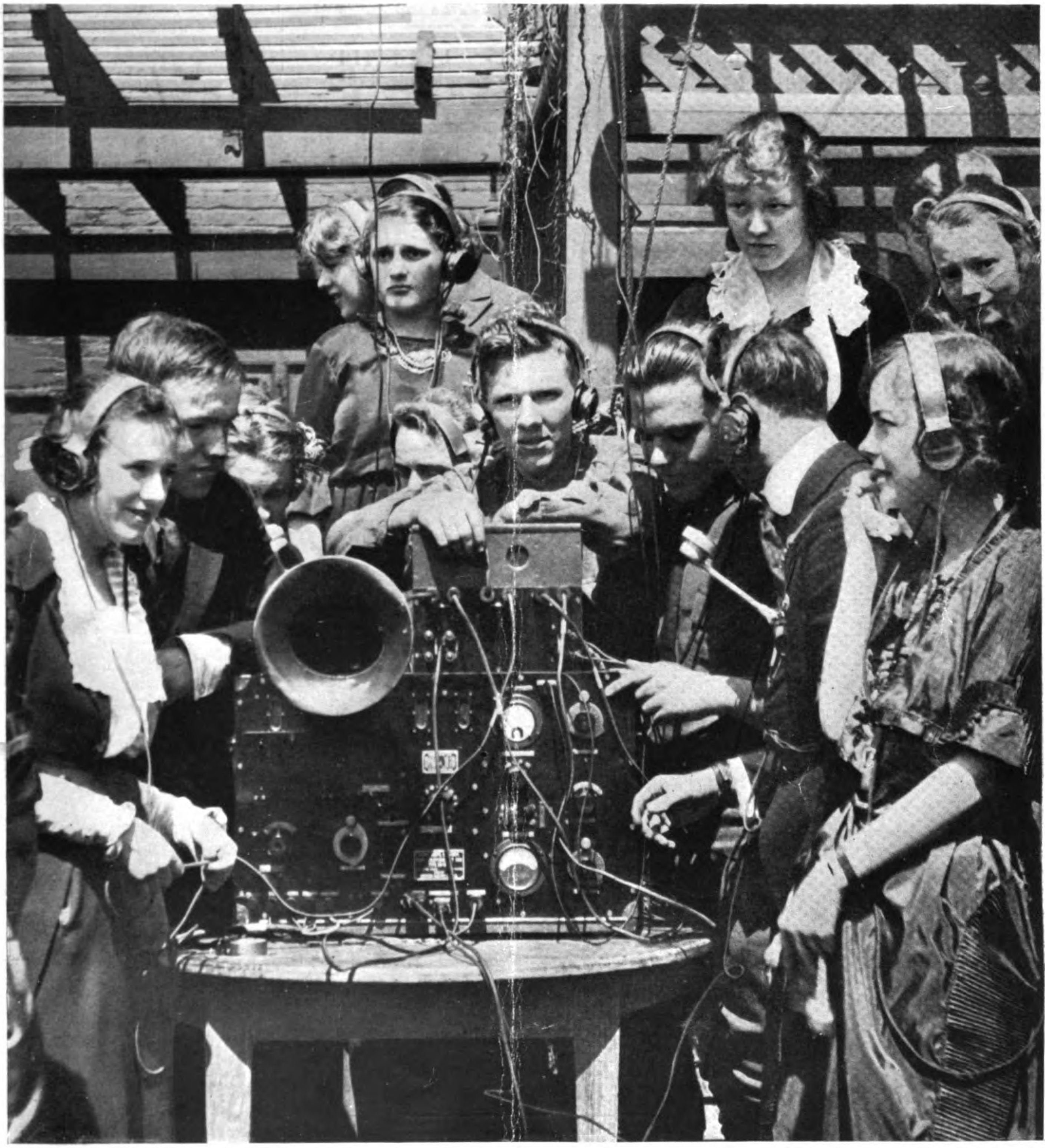
Volume 7
Number 9



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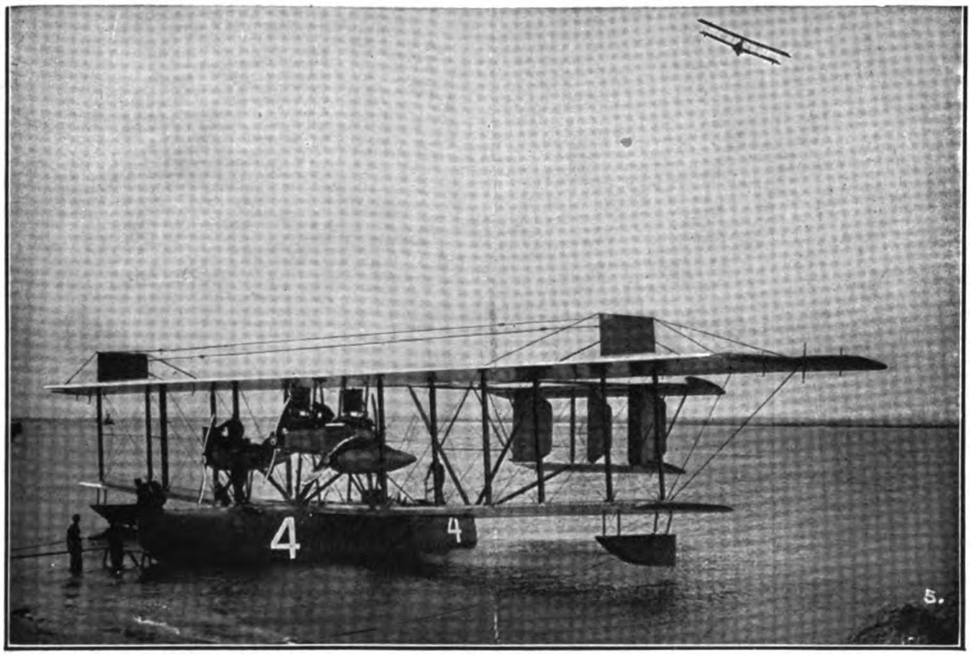
Extract from New York World, June 3, 1919.



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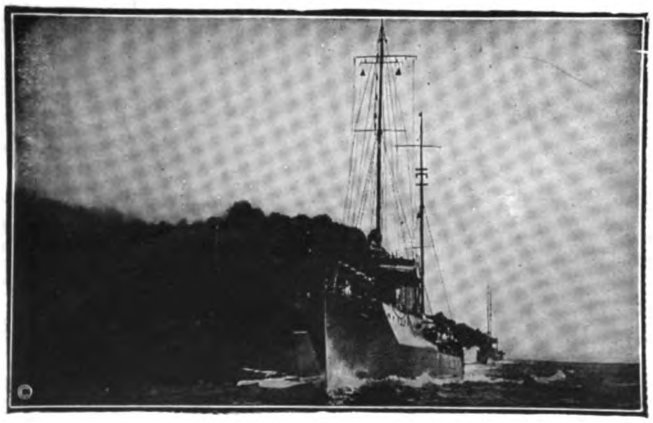

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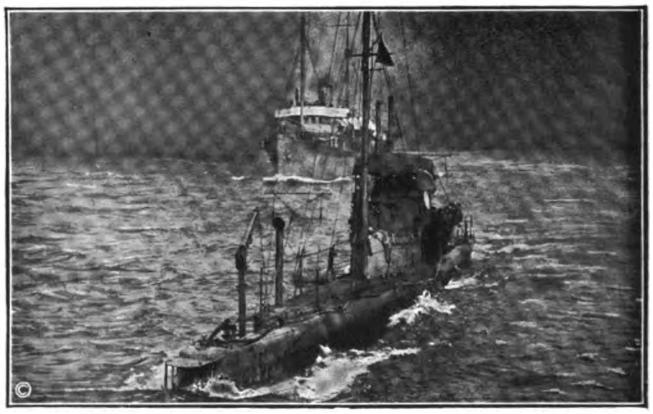

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Edited by J. ANDREW WHITE

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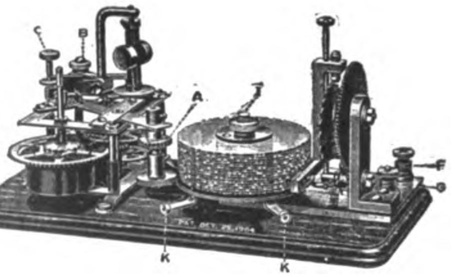

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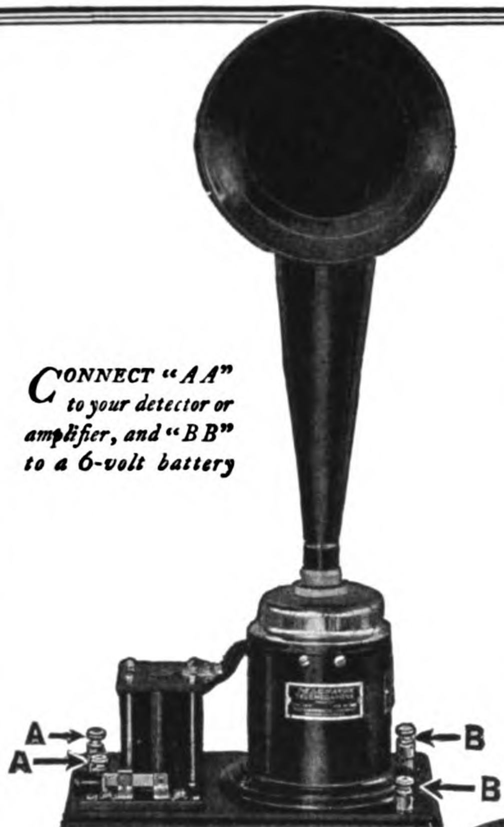

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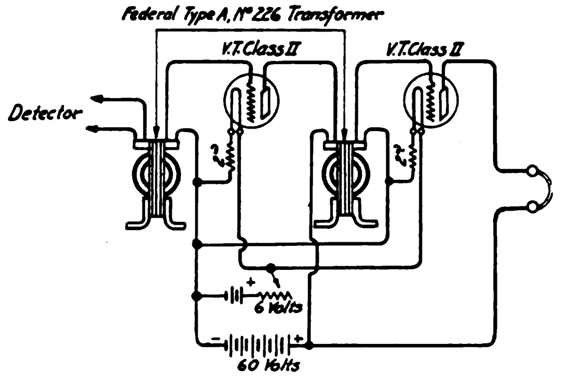

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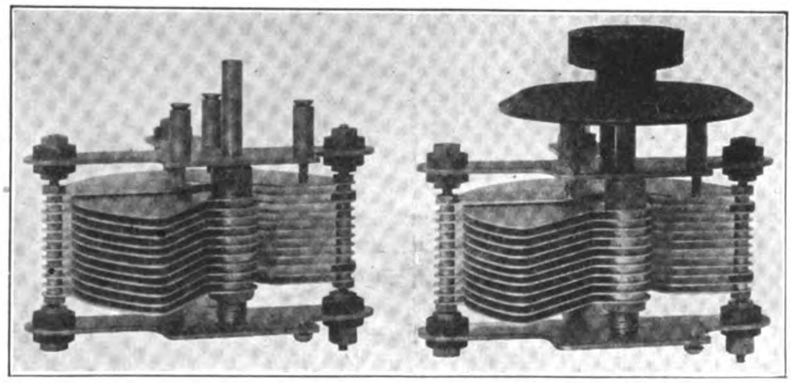

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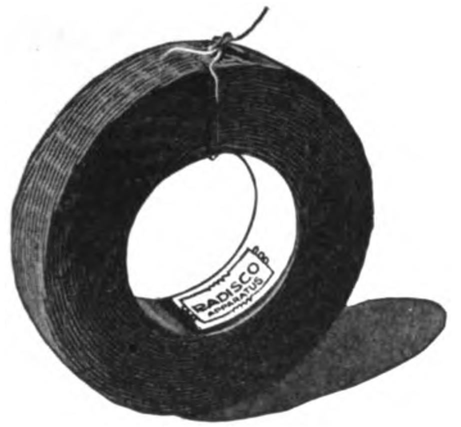

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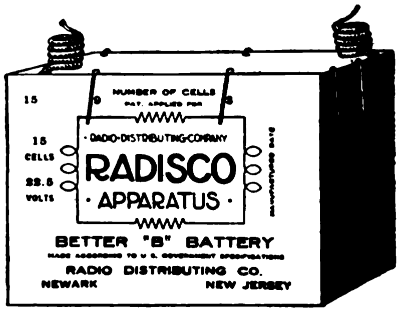
is made according to Government specifications in two (2) sizes—3¼x2x2¼" and 6¼x4x3". A first-class 15 cell, 5 group battery, VARIABLE VOLTAGE (Pat. applied for) is a special feature of this battery which enables you to provide critical voltage regulation for your vacuum tube by means of a switch connection with cells, taps of which have been taken off. Very economical and convenient. If one cell goes bad just test each group of 3 cells and short circuit the bad one. Price, small size, $1.40. Large size, $2.40, at any agency, or if ordered by mail include postage for 2 pounds on small size and 5 pounds on large size.

RADISCO AGENTS carry only apparatus of proven merit. Look for the Radisco trade mark on all parts you buy and be sure of getting efficient apparatus.



Below are listed a few of the reliable firms who carry the RADISCO COILS, Better "B" Batteries and are our Agents for all other standard apparatus of merit.

COMMUNICATE YOUR WANTS TO THEM.

ALBANY, N. Y.
E. L. Long,
21 Magnolia Terrace

ATLANTIC CITY, N. J.
Independent Radio Supply Co.
118 So. New Jersey Ave.

BALTIMORE, MD.
Radio Engineering Co.,
614 No. Calvert St.

BEINVILLE, QUEBEC, CAN.
Canadian Radio Mfg. Co.

BOSTON, MASS.
Atlantic Radio Co.,
88 Broad Street

BROOKLYN, N. Y.
Kelly & Phillips Electric Co.,
312 Flatbush Ave.

BRONX, NEW YORK
Amateur Wireless Equipment Co.,
1390 Prospect Ave.

CHICAGO, ILL.
Chicago Radio Laboratories,
1316 Carmen Ave.

EUREKA, PEORIA, ILLINOIS
Klaus Radio Co.

HAMPTON, N. H.
DeLancey Felch & Co.,

LOS ANGELES, CALIF.
The Wireless Shop,
511 W. Washington St.

McKEESPORT, PA.
K. & L. Electric Co.,
427 Olive Street.

NEW ORLEANS, LA.
L. A. Rose,
121 Camp Street

NEWARK, N. J.
A. H. Corwin & Co.,
4 West Park Street.

NEWCASTLE, PA.
Pennsylvania Wireless Mfg. Co.,
507 Florence Ave. "8HA"

PHILADELPHIA, PA.
Philadelphia School of Wireless Telegraphy,
Broad and Cherry Streets.

PROVIDENCE, R. I.
Rhode Island Elec. Equip. Co.,
45 Washington Street.

PITTSBURG, PA.
Radio Electric Co.,
4521 Forbes St.

SCRANTON, PA.
Shotton Radio Mfg. Co.,
P. O. Box 3
Branch 8 Kingsbury St.,
Jamestown, N. Y.

SPRINGFIELD, MASS.
Electric Service Co.,
585 Armory Street.

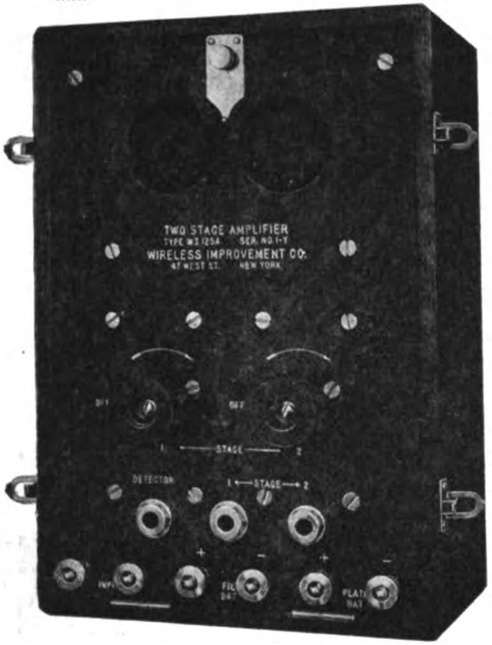
TORONTO, ONT., CAN.
The Vimy Supply Co.,
585 College Street.

WASHINGTON, D. C.
National Radio Supply Co.,
808 9th St., N. W.

WICHITA, KAN.
The Cosradio Co.,
1725 Fairmount Ave.

If none of the above agencies are in your vicinity, communicate with

RADIO DISTRIBUTING COMPANY : : Newark, New Jersey



Two Stage Amplifier,
Type WI-125A
Price: $75.00

WICONY

Versus

Ordinary Apparatus

Did it ever occur to you that when you install that new amplifier, audion control box, receiver, or whatever it is you have in mind, you will want to call in some of your friends and acquaintances and show them your new apparatus? Do you realize that among others, there will be radio men who know *REAL* apparatus when they see it? Do you want them to remark, probably outside your hearing, that "your equipment may be all right for the amateur and experimenter, but of course the Navy and other concerns who *KNOW*, use a better grade?"

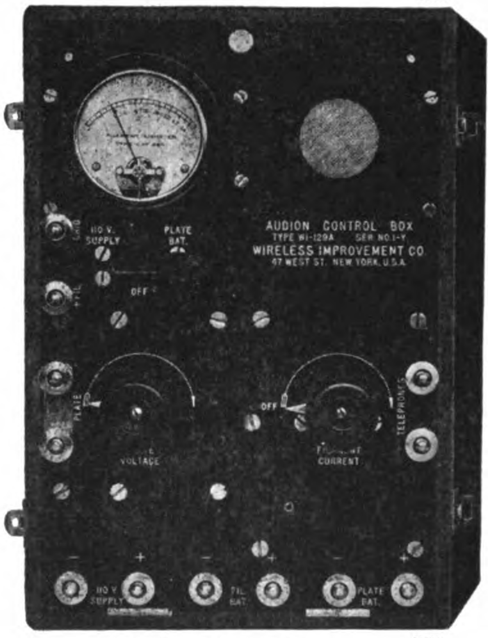
If these thoughts should ever run thru your mind you can avoid any chance of being dissatisfied by purchasing WICONY apparatus, the standard Navy type of equipment.

We do not build a line especially for the amateur and experimenter because we believe the amateur and experimenter should use regular apparatus. We do, however, sell our standard Navy type apparatus to the amateur at a price so low that we often hear the remark "How can you do it?" The answer is that the bulk of our business is with the United States and foreign governments—who buy in quantities—and in selling the same apparatus to the amateur, he gets the benefit of prices due to quantity production.

Observe from the following, picked at random, how little more it costs to get apparatus you *KNOW* you will never regret having bought, and which you will always be proud to show to *ANYBODY.*

		Price
Type WI-106A	Audion Control Box (without filter system) .	$60.00
Type WI-110C	Audio Frequency Amplifier Transformer . .	7.00
Type WI-125A	Two Stage Audio Frequency Amplifier . .	75.00
Type WI-126A	Dust-proof, glass enclosed, U. S. Signal Corps Type Crystal Detector	4.50
Type WI-129A	Audion Control Box (including 110 V. filter system)	75.00
Type WI-149A	Marcuson Plate Battery	12.00
Type WI-163A	Western Electric Type Head Telephones . .	14.50

We can make immediate shipment of the above apparatus



Audion Control Box,
Type WI-129A
Price: $75.00

WIRELESS IMPROVEMENT COMPANY

RADIO ENGINEERS, MANUFACTURERS AND DISTRIBUTORS
47 WEST STREET, NEW YORK, U. S. A.

If this page is cut out and appended to the same page cut from the editions to follow, a complete file of very interesting information will soon be available. (No. 6)

Vol. 7. No. 9. JUNE, 1920

THE WIRELESS AGE

WORLD WIDE WIRELESS

Radio Corporation Holds First Meeting

IMPORTANT developments in long distance wireless communication were announced at the annual meeting of the Radio Corporation of America held in the Woolworth Building, New York, on May 4th, the first meeting to be held since the merger was effected between the General Electric Company and the Marconi Wireless Telegraph Company of America.

Edward J. Nally, in his address to the stockholders, stated in connection with the agreement with the General Electric Company: "It brings to our commercial department the co-operation of that company's world-wide organization, and, what is probably the most valuable asset of all under the agreement—exclusive control of the Alexanderson Alternator. This device bids fair to practically revolutionize the art of long distance communication by wireless. The report comes to us that the signal transmitted from our American stations equipped with the Alexanderson Alternators has attracted the attention of the wireless experts of Continental Europe. It is said they wonder what manner of device it is that sends a signal so noticeably superior to that to which they are accustomed. Already, the British Marconi Company has adopted the Alexanderson Alternator to be purchased from the Radio Corporation as its standard high frequency apparatus for communicating for distances exceeding 2,000 miles. Commissions or representatives of the Governments of Poland, Denmark, Sweden and other foreign countries, have been sent here to investigate and examine it, with a view to procuring sets for their stations. It is safe to predict that as a result of these investigations it will soon be conceded your company controls the world's foremost device for long distance wireless communication. The resultant advantages to the company, both financially and in the way of prestige, are readily apparent."

Mr. Nally also stated that "a representative of the United States Government in the person of Admiral Bullard of the U. S. Navy has been designated by the President and Secretary of the Navy to attend the meetings of our stockholders and Board of Directors, with view to a close co-operation between the Government and the company. This interest on the part of the Government and its full accord with our program has already proved helpful through gaining the assistance of the State and Navy Departments in connection with certain of our dealings in European and South American countries."

It was also announced that the Board of Directors has approved a large program of construction for the near future. It is proposed to immediately purchase a site near New York City for a group station of five units, the station when completed to be devoted to the following purposes: one unit to work with Buenos Aires, Argentina; one to work with France; one to work with Germany; one to work with Scandinavia; and one with Italy and Poland.

The following were elected to the Board of Directors: Edwin W. Rice, Jr., Albert G. Davis, Owen D. Young, Gordon Abbott, James R. Sheffield, John W. Griggs, Edward W. Harden and Edward J. Nally.

Officers were elected at the Board meeting on the following day: Owen D. Young, Chairman of the Board; Edward J. Nally, President; Charles J. Ross, Secretary; George S. DeSousa, Treasurer; Hon. John W. Griggs, General Counsel.

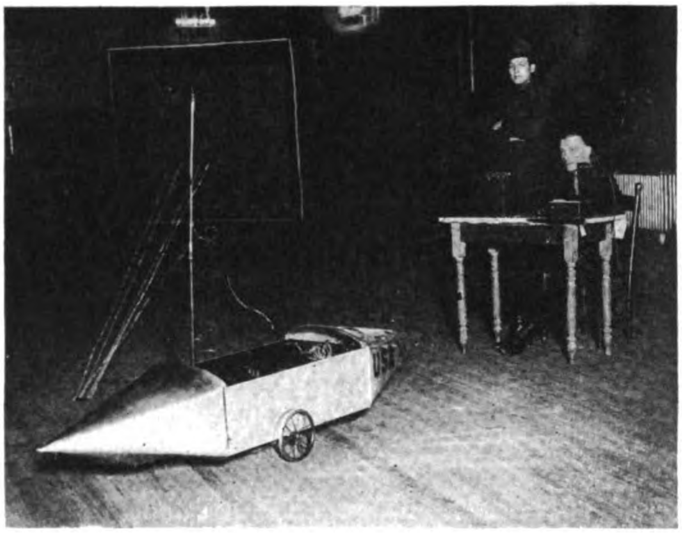


Photo Int'l

Wireless controlled torpedo demonstrated at the 12th Regiment Armory, New York

Radio Message From Amundsen Breaks 19 Months' Silence

CAPTAIN Roald Amundsen, discoverer of the South Pole, has arrived at Anadir, a trading post on the Bering Sea, in Eastern Siberia, according to a wireless message from Anadir, received at Nome, Alaska. The dispatch gave no details other than suggesting that the explorer had reached the village in a ship.

For more than nineteen months the silences of polar seas have shrouded the vessel that bore Amundsen and his shipmates in their unusual endeavor to reach the North Pole.

◆

Wireless Service Between England and Egypt

THE British Post Office is hurrying the construction of two new high power wireless stations to supplement cable service between England and Egypt. Cable companies have also laid new lines between England and Gibraltar and between Malta and Alexandria. Another new line between Aden and Bombay is to be laid this year.

Cable congestion in the Near East, India, the Far East, South Africa and Australia was recently made the subject of inquiry by the Federation of British Industries.

Chess Played by Wireless

A GAME of chess played by wireless between Edward Lasker, of Chicago, and A. F. Whittaker, of Washington, awaits decision by J. R. Capablanca, Pan-American chess champion, as to the victor.

The moves by the Washington man were telephoned from the Capital City Chess Club to the naval operator at the Arlington wireless station. Messages were received at an amateur's station in Evanston, and relayed to the Illinois Athletic Club.

It is said the game proved to be much faster than those played by telegraph and chess play by radio may be the means of reviving the cable-matches that formerly were played between English and American teams.

Photo Int'l

Dancing to music transmitted by radiophone. Illustration shows headsets being adjusted

Radio a Practical Aid to Fishing Industry

WIRELESS communication in conjunction with the airplane has become a valuable stabilizer for the fish packing industry of Southern California, following a program of co-operation which has just been outlined with officials of the North Island aviation school by members of the state fish and game commission.

Airplanes have become "spotters" for the fishing fleets of canneries and as a result reliable information is being obtained which has tended to stabilize the industry.

The planes, flying over the sea are in constant lookout for fish schools which can be easily sighted from an airplane, says Fish and Game Commissioner M. J. Connell. By wireless information is then flashed to the headquarters of the commission in Los Angeles and this information is immediately distributed to all fish packing plants of the location of fish schools.

* * *

Radio Service Aboard Trans-Atlantic Ships

SUCH striking results have been obtained by the new long distance Marconi wireless sets on board the Cunarders Imperator, Mauretania and Carmania that a rapid extension of these instruments to other great liners may be expected. The White Star vessels Olympic, Adriatic, Baltic, Celtic, Cedric and Megantic are being similarly equipped. All these ships will now have direct intercommunication with land over a distance of 1,400 miles. Radio-telegrams intended for passengers may be handed in at any post office in England. The word "Aberdeen" must be included in the address after the name of the ship. The charge for such radio-telegrams is 10½d per word.

Marconi Welcomed in Spain

NEWS of the arrival in Spain of Guglielmo Marconi and of the enthusiastic popular reception accorded to the distinguished inventor in that country serves to draw attention to a voyage which has been pronounced comparable in a way to the venture of Columbus. The voyage of the Electra has excited great interest in scientific circles.

Marconi expects upon his voyaging, which may be extended, to make a special study of atmospheric and meteorological conditions as these may affect wireless communication and to chart his findings, it being expected that these will prove of importance in respect particularly to the problem of standardizing communication through the air in all parts of the world.

* * *

The Passing of Theodore Newton Vail

THEODORE NEWTON VAIL, chairman of the board of directors of the American Telephone & Telegraph Company, died April 15, in the Johns Hopkins Hospital, Baltimore, Md.

Mr. Vail came from Jekyl Island recently for a slight operation. He had been in a rather serious state of health. He was born in Carroll county, Ohio, July 16, 1845.

Theodore N. Vail was among the many successful Americans who got their start in life by learning telegraphy. This list of former telegraphers includes such men as Andrew Carnegie and Thomas A. Edison, and Mr. Vail, in his chosen field, was as successful as they were in theirs. So successful, in fact, that in 1907 he became the head of the largest telephone company in the world, the American Telephone and Telegraph Company.

When Alexander Graham Bell invented the telephone, Mr. Vail was just 31 years old, but he quickly saw the possibilities of conversations by wire.

His first line was from Boston to Providence, and he was ridiculed for the attempt. It was called "Vail's side show" by the scoffers, but it really was the start of one of the greatest developments in modern life. Thirty-five years later, in 1915, it was possible to talk from New York to San Francisco, and in the same year it was possible to talk by wireless telephone from Arlington, Va., to the Eiffel Tower in Paris and to Honolulu simultaneously.

It was his frequently expressed belief that the next few years would produce wireless telephone communication of practically unlimited distance and effectiveness.

* * *

Newsy's Interest in Radio Results in Robbery

THE burglar who appropriated a complete wireless receiving apparatus from a supply house in New Haven, Conn., has been captured. LeRoy B. Dortche, age 15 years, is the name the accused gave at police headquarters. He said he was a student of radio and intended setting the apparatus up in his home and "listening in" on distant radio stations of the world. He said he delivered morning papers about the city, and while out early in the morning he took advantage of the opportunity to secure the instruments, which he had yearned for ever since he became interested in radio-telegraphy.

* * *

American Freighter Mystic Rescued by Radio

RADIO advices received by the Naval Communication Service announced that the coast guard cutter Ossipee had found the disabled American freighter Mystic 400 miles east of Sandy Hook and was standing by. The Mystic sent a call for help saying that she was disabled and was out of fuel and fresh water. The disabled vessel was bound from Avonmouth for New York.

The 3,000-Mile Iowa Radio Relay Test

THE Iowa Aerial Daylight Relay test with neighboring states, covering a territory of about 500,000 square miles, was successfully carried out, according to Clifford W. Patch, district superintendent of Iowa. The message, sent around to a number of stations, was planned to discover how rapidly the various stations could receive and transmit messages. Many cities in Iowa, Illinois, Wisconsin, Minnesota and North Dakota participated in the test.

The message, which was started from Patch's station in Dubuque, read: "Progress today depends more and more upon speed and snap. Radio furnishes the speed. You furnish the snap."

The message was sent on three routes. Route number one, beginning at Dubuque and ending at Minneapolis, was the longest, and the message, starting at 8 o'clock, closed at 10 o'clock. There were twenty-six stations on this route, through which the message had to be relayed.

Radio Compass Guides Airplanes

A RADIO compass for airplanes which will enable them to locate other planes accurately regardless of weather conditions has been successfully tested by navy flyers. On a recent trip of the NC-3 from Philadelphia to Pensacola that machine and another from Anacostia, D. C., field were equipped with the new compass.

Officials at Anacostia kept in communication with the NC-3 constantly by wireless and took bearings at stated intervals on both planes by means of the compass.

The two planes were directed toward each other from the field until, when sixty-five miles apart, the compass of each came into operation, confirming their positions and establishing communication.

S O S Radio Service

DISTRESS calls from two vessels, each outbound from New York, were received by radio recently stating both ships were fast filling with water. Assistance was rushed to them.

The first S O S was received from the freighter E. A. Morse, which was steaming for Genoa. It said: "We have no steam; are filling rapidly." She was then 280 miles southeast of New York.

"We may be able to keep afloat for two or three hours," ran a later radio from the Morse. The Acushnet, a coast guard cutter, and the San Mateo, bound from Boston to the West Indies, headed for the disabled craft.

The wooden steamer William O'Brien, three days from New York bound for Rotterdam, wirelessed from a position about 500 miles east of Philadelphia:

"Hatch covers off; taking water rapidly. Please stand by."

The coast guard cutter Acushnet, which has been searching for the disabled steamer William O'Brien, reported by wireless that she found the sea covered with fuel oil and a name board of the steamer drifting about 500 miles east of New York. An empty life boat was picked up in the same locality.

It is feared the steamer went down not long after she had asked for assistance during a gale. She left New York for Rotterdam.

Radio Brings Aid to Ship off Fire Island

THE Naval Communication Service recently received a wireless announcing that the Coast Guard cutter Seminole had taken the Shipping Board freighter Ipswich in tow about eighty-five miles east of Fire Island. The message failed to disclose the nature of the freighter's trouble, but stated the craft was not in danger. The Ipswich, of 3,700 tons, was bound for New York from London.

Uncle Sam Has 135 Wireless Stations

THE government shore wireless stations number 135, of which eighty-eight are in continental United States, twenty in Alaska, nineteen in the Philippines, three in the canal zone, two in Hawaii and one each in Porto Rico, Guam and Samoa. The government ship stations total 470.

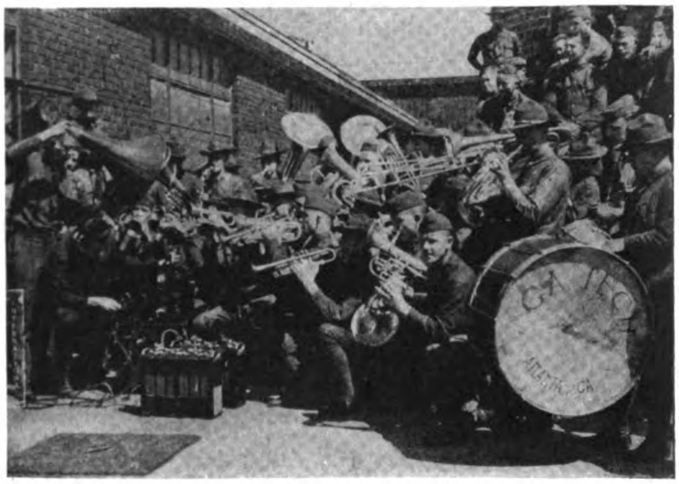


Photo Int'l.

Band rendering dance music that was transmitted by radiophone

Pacific Coast Radio Compass Stations

FOG will soon be robbed of its dangers to Pacific Coast shipping by means of radio. The opening of the naval radio compass stations on the Pacific Coast is but a few weeks off. The first will be four stations at the entrance of San Francisco Bay, at Point Montara; Bird Island, near Point Benita; Point Reyes, north of Point Reyes lighthouse, and Farallon Islands.

The method of operation is based on determining the direction of radio waves. The vessel, concealed in fog, sends out radio signals. Each of the radio stations intercept these signals, and by compass radio determines from which direction they come. Each station notifies a central station, which in turn notifies the vessel the precise direction it is from the station, and these directions charted show by intersection of the lines the vessel's precise location.

Due to shortage of enlisted personnel, the opening of all stations cannot be expected at present, but it is the intention to open at the earliest possible date one station, probably Bird Island, at the northern enrance of the Golden Gate, as soon as personnel can be trained.

Radio Realizes the Horse Marines

ENGLISH sea captains are betting on the races—by wireless. The first week of the opening of flat racing brought a number of turf transactions flashed from the high seas, passengers as well as ship masters and officers ordering their bookmakers to place bets on "live ones."

A system of flashing racing "tips" by radio is being fast developed.

Radio Telephony Across Oceans and Continents

By Dr. Alfred N. Goldsmith

Director of the Radio Laboratory, The College of the City of New York

Dr. Goldsmith, who looks forward to a not far distant date when every telephone subscriber will have direct access to the radio telephone

THE recent announcement by Senatore Marconi that we may shortly expect to telephone by radio across the Atlantic and that regular service will be available, is both startling and encouraging. It is clear, for example, that in the comparatively near future the president of any large corporation will be able, from his desk in any town in the United States, to telephone to the managers of his branch offices in distant countries. In effect, London, Rome, Paris, Tokio, Cape Town and Buenos Aires will be as much within his immediate reach as his next-door neighbor.

This revolutionary step forward in communication marks the beginning of a new era. From the days when fast runners laboriously carried messages over moderate distances to fall exhausted at the end of their trying trip, communication has never been quite capable of meeting all the demands on it. The loss of time in getting word to the other man is more of a brake on efficient business than almost any other single factor; but there has been tremendous progress made, and more is expected for the near future. Already it is possible to send radio messages from the United States to Hawaii and Japan on the one hand and to England, France, Italy and Norway on the other.

The great stations now in existence in the United States, or planned for the immediate future, will extend this range of communication until telegraph messages can be sent speedily to any corner of the world.

A very natural question which the individual user of the radio telephone of the future will desire to have answered is: "How shall I send a radiophone message to Mr. William Brown in London? Just what will I have to do to get the connection and to talk to him? How will it sound? And what will it cost?" It is fortunately possible to answer some of these questions fairly definitely today.

All that Mr. Smith will have to do in New York to talk to Mr. Brown in London, is to take his telephone receiver off the hook and ask either for "Radio Long Distance" or for the number of the special high power radio telephone transmitting station which will carry his voice across the Atlantic. As soon as he gets the long distance radio station, he will be asked by the operator to whom he wishes to speak. On giving the name and address of the desired man in London, he will be told to "Hang up the receiver, please. We will call you when your party is ready." In a few minutes his telephone bell will ring, and he will be told "Your party is ready: go ahead, please"; and he will be in touch with his correspondent in London.

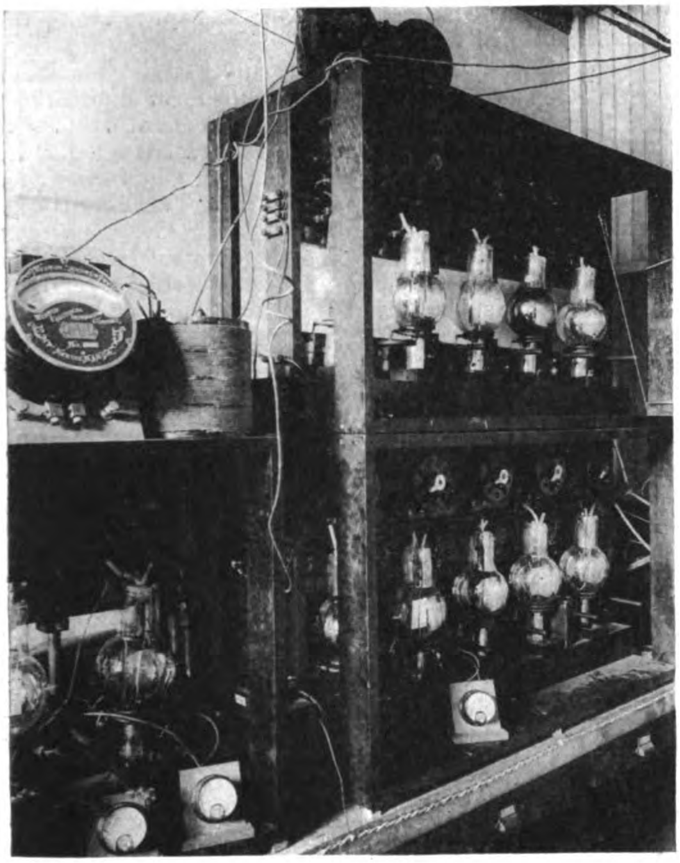
It will not be necessary for him to leave his office or his home, or wherever he happens to be, to telephone to any point that he desires. Every telephone subscriber will become automatically a subscriber to the radio telephone without further expense or trouble on his part.

As regards the connection itself, it is certain that the speech will be clear and easily understood. There may be a little difficulty about the language when a subscriber in Rio de Janeiro talks with a subscriber in Vladivostok, Russia, but this cannot be blamed on the radio telephone. We shall all have to become accomplished linguists to utilize to the full the immense possibilities of this new means of long distance communication. Or else the long deferred hope of the adoption of Esperanto, or some such universal language, will have to be realized.

As regards the cost of a radiophone message to far distant cities, this will naturally depend on a number of things which cannot be accurately measured today. Of course, the further the message must be carried by wire lines to the radiophone stations, the more expensive it will be. And the further the radiophone stations send it over ocean or continent, the higher the cost. And the time of day and speed with which the connection is demanded will probably have to be considered also. If a man is willing to telephone during the slack period late in the evening or early in the morning, he will probably get reduced rates.

In any case, it is clear that the radiophone should not be used for casual gossip between Chicago and Melbourne, Australia. On the other hand, it is likely that the rates for a three-minutes talk to London, Paris, Rome, or any other of the greater European capitals from the chief American cities, will be well within reason and entirely worth while if important matters are to be handled. During the slack hours the rates will probably be such as to permit the use of the radiophone on special family occasions, such as weddings, births and so on, even by most of us.

Of course, the chief users of the long distance radiophone will be the larger commercial interests and the banking houses. Their business is handled best at high speed, on short notice, and by competent men in effect speaking face to face. There are, however, many other uses of the radio telephone, which, while less spectacular and over shorter distances, will nevertheless be very valuable to society. Ships at sea will be in telephone



Dr. Goldsmith's radiophone set, showing the dozen vacuum tubes which were used to generate several horsepower for wireless telephony regularly conducted over a distance of 160 miles

touch with land. Any traveler who is immune from seasickness should have no difficulty in calling up his office from mid-ocean and making sure, by direct question and answer, that all is going well. Or he can call up the other side of the ocean, personally arrange for accommodations, and even make his business appointments and outline the matters he wishes to talk over when he arrives. If, as now seems likely, the radio telephone is used to a considerable extent on the better through-trains, the railroad trip will be much less of a loss of time than it is at present. The traveler on the future Pullman, equipped with its radio telephone set, will be in personal contact with any point in the country which he desires to reach. In fact, if a passenger on the "20th Century Limited" desires to speak by telephone direct to a passenger on the "Mauretania," in mid-ocean, or to a business associate in Madrid, it is quite within the bounds of possibility that he will be able to do so.

The man who does not want to be reached by those who want to speak to him him will not have much chance in the future. As soon as he approaches any telephone booth or enters his office or home, he is at one end of a wire, the other end of which reaches practically to any important point in the habitable globe.

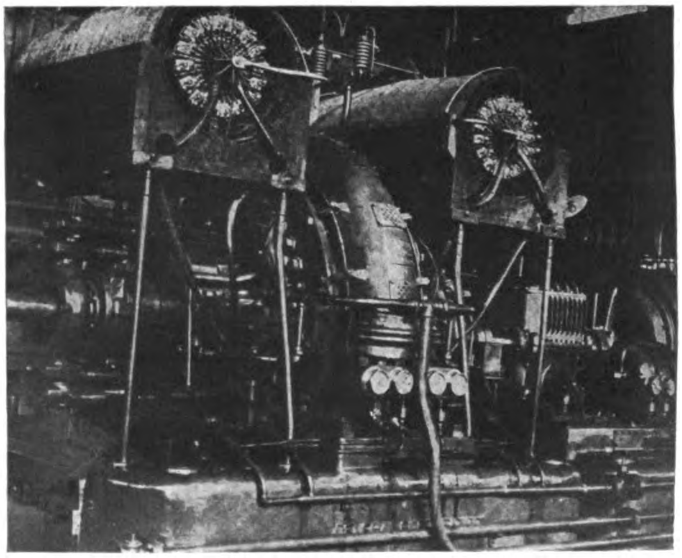
To carry out the plans mentioned, will require the erection of a number of high power radiophone stations here and abroad. These sending and receiving stations will be connected to the ordinary telephone lines of the country in which they are situated. That is all that is necessary to enable them to be fully used by the telephone subscribers of that country. Every radiophone message will go by the wire lines from the subscriber to the radiophone transmitting stations, then by radio across ocean or continent to be received at the radiophone receiving station and automatically transferred to the wire lines in the distant country leading to the called party. The reverse holds for everyhing the called party says. It will be noticed that the spoken words are automatically transferred twice, once at the radio transmitting station and once at the radio receiving station. This will be done instantaneously and accurately without human intervention, by the remarkable "amplifiers" which have recently come into extensive use. So that, long-distance telephone communication will have in it two short wire links, on each side of the ocean and a long stretch of air, which will be bridged entirely by radio.

There are two important ways of transmitting wireless telephone messages successfully; the bulb and the alternator.

The bulb method uses vacuum tubes, which look like large lamps but have remarkable possibilities in the way of producing and controlling the highly special currents required to carry a radiophone message. These bulbs are made of special glass which will not melt when subjected to a high temperature and other difficult conditions of operation. Inside the bulb, from which practically all the air must be carefully removed, are placed appropriate metal parts. One of these is the brightly glowing filament, somewhat as in an ordinary tungsten lamp. Another is a plate of some special metal, usually tungsten or nickel. A third metal part known as the grid may be placed in the tube. Or else, to accomplish similar results in a different way, a third metal part may be fastened outside the tube. These lamps, which in their way are as wonderful as the one used by Aladdin to evoke the genii, are capable of taking the faintest electric currents and "amplifying" or increasing their effect until hundreds or thousands of horse power are controlled by the voice of the speaker! These bulbs are also capable of producing currents that alternate or reverse millions of times in a second! In a smaller form, they are used for receiving the signals as well.

The original effect on which these bulbs are based was discovered by Edison, but they were first successfully applied in a basic and fundamental way to radio telegraphy by Professor Fleming, the eminent English electrical engineer. Substantial improvements have been made in these bulbs by Dr. de Forest, the American inventor, Dr. Langmuir of the Research Laboratory of the General Electric Company, and Mr. Roy A. Weagant of the Radio Corporation of America. America can well be proud of the share her scientists and engineers have played in the development of this remarkable device, the vacuum tube amplifier, oscillator and modulator.

When one of these bulbs does not supply sufficient power to telephone by radio the desired distance, a number of them may be connected up to work together successfully.



The New Brunswick high power station of the Radio Corporation of America, equipped to enable wireless to carry the spoken word over land and sea; the photo shows the giant 200-kw. high frequency alternator with dynamo at the right and the transformers on top

Nearly five years ago the writer used a radiophone set employing these bulbs as shown in the illustration. It will be seen that a dozen of these large "radio lamps" were used to generate several horsepower which was then sent out from the aerial wire system stretched over the buildings of the College of the City of New York, also shown in an accompanying illustration. This set enabled the writer to telephone by radio to Schenectady, 160 miles distant, at almost any time. This was by no means the greatest distance over which the words could be heard when conditions were favorable. In fact, words spoken at the Laboratory in New York were clearly heard in North Dakota, 1,300 miles distant, on numerous occasions! At the time this work (which was carried on in conjunction with the General Electric Company) was done, it was close to being the world's long-distance record for radio telephone communication.

Interesting work along these lines has been carried on by the United States Navy and the Western Electric Company. Not only were long distance tests carried out, but excellent radio telephone communication with airplanes and over short distances for military purposes were achieved.

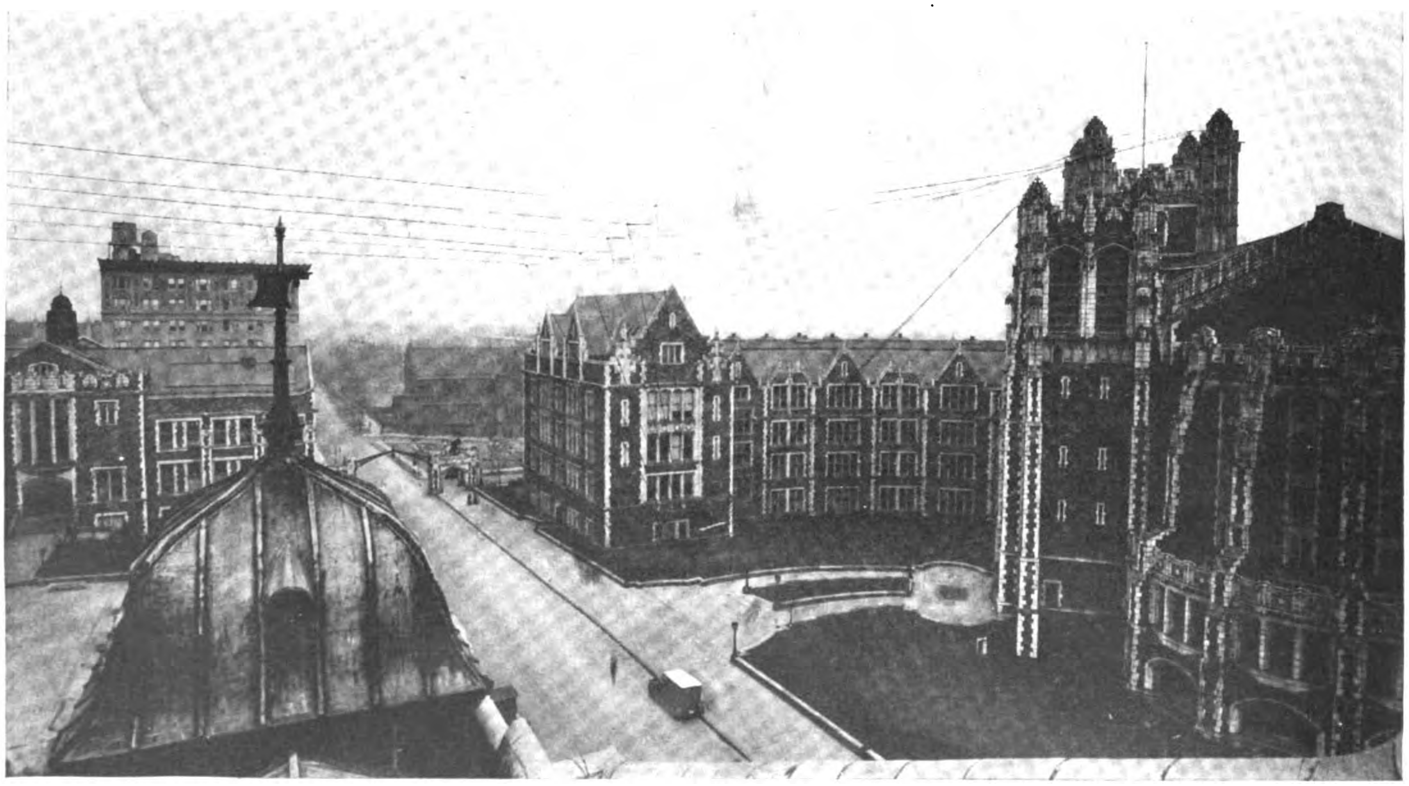
The equipment used by the English Marconi Company to telephone across the Atlantic recently was very similar in nature and operation to that used by the writer and mentioned above. It also consists of a number of appropriate bulbs, acting together, and producing the "modulated aerial current" needed for this purpose. In the writer's earlier experiments it was found possible to talk by radio telephone from points quite distant from the laboratory. For example, speaking from a residence seven miles away from the laboratory, it was possible to transfer every word spoken automatically to the radio telephone and send it out to the desired destination. This was quite along the lines mentioned above.

There is a second way of sending radio telephone messages, using an alternator. The form found most desirable in America and giving excellent results is known as the "Alexanderson Alternator" after its inventor, Mr. E. F. W. Alexanderson, Chief Engineer of the Radio Corporation of America. These machines were developed by the General Electric Company over a long period of years and are powerful and sturdy generators of the currents required to send over long distances. It is likely that the alternator will compete successfully or even supersede the bulb radio telephone transmitter when very long distances are to be covered. These machines are triumphs of careful engineering. Their rotating parts, made of the finest steel with most accurate machining, spin at an unusually high speed and require careful balancing and centering. They have proven themselves capable of handling heavy radio telegraph traffic from the United States to our Allies through the war.

When President Wilson sailed to Europe on the "George Washington," radio telephone messages from Secretary Daniels of the Navy in Washington were sent to the President all the way to France. The equipment used was the Alexanderson alternator with its bulb and magnetic amplifier controls. More recently, radio telephone messages have been repeatedly sent from the New Brunswick, N. J., station of the Radio Corporation of America, to France, using this equipment.

Efficient radio telephone service in America requires two things: mastery of the art in America, and proper working arrangements with competent foreign radio companies. Fortunately, both of these conditions have been met.

Quite recently, the General Electric Company and



The aerial wire system at the College of the City of New York, connected to the wireless 'phone apparatus installed in the building at the right; words spoken here were clearly heard in North Dakota, 1,300 miles distant, on numerous occasions the Marconi Wireless Telegraph Company of America concluded arrangements whereby their radio interests in the future will be handled by a great all-American company, the Radio Corporation of America. Suitable working arrangements have also been made between the Radio Corporation and the English Marconi Company and its associated companies. Controlling, as it does, practically all the high power stations in the United States (with the exception of those belonging to the United States Navy), with American engineers and capital back of it, and strongly fortified by suitable arrangements with its foreign correspondents, the Radio Corporation will unquestionably maintain the present high standing of radio in the United States and insure our future prestige and standing.

One of the powerful Alexanderson alternators used for radio telephony at the New Brunswick station of the Radio Corporation is shown herewith. Controlled by the delicate voice currents, such machines as this will carry the spoken word over land and sea. The beneficial influence of this triumph of science will be felt in many different ways. The speeding up of business and production, the ready correspondence with our friends in times of emergency, the simplification of foreign affairs in diplomacy and the safety of life at sea will be but a few of the great results of radio telephony in the future. As communication advances, the world shrinks and dwellers in far distant lands become our next-door neighbors.

Marconi as he is today; this picture shows the distinguished inventor on board his yacht shortly after he announced that there will soon be regular radiophone service across the Atlantic

What the Amateur Can Learn from the Navy

By Robert J. McAusland, Jr.

MR. LAWRENCE C. F. HORLE, formerly United States Navy expert radio aide, in a talk before the Radio Club of America recently, made it clear to anyone familiar with the development of amateur receivers, that history can and did repeat itself in the case of the navy receiver design.

Although Mr. Horle's talk thoroughly covered the trend of development for the period of the last three years, we shall not attempt to explain in detail all of the designs. The problem that confronted the navy consisted of the following elements: Facing war, it became necessary to produce large numbers of receivers for use on naval boats, which would live up to the severe service required. The specifications laid down for these receivers were five in number. First, they must have a wide range of wavelengths; second, they must have a high selectivity and sensibility over the range covered; third, ease of operation must be secured, so that inexperienced operators could be used; fourth, the design must be light and compact and yet capable of giving service during heavy gunfire; and, fifth, ease and economy in manufacture were of paramount importance.

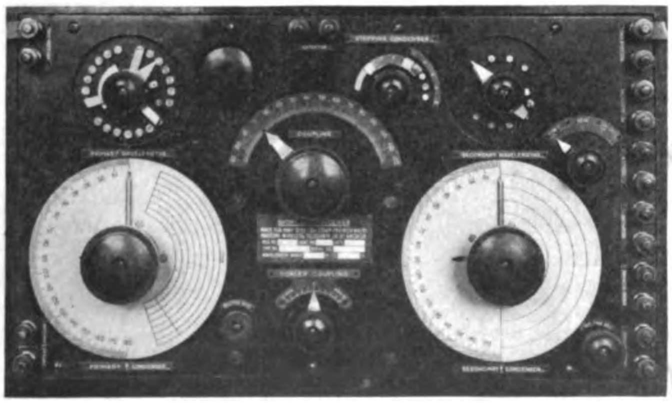


Figure 1—Front view of CM 294C receiver

The method by which the navy found solutions to these problems led to the development of apparatus of standardized design incorporating the features just outlined.

The reader may find some points of interest in the navy design and by utilizing them he may find a solution of his problems along the lines of the above mentioned five specifications. For example, many an amateur may use to advantage such standard parts as condenser plates, knobs, binding posts, etc., which he can buy cheaply in the open market, and by assembling some of his own apparatus save a few dollars.

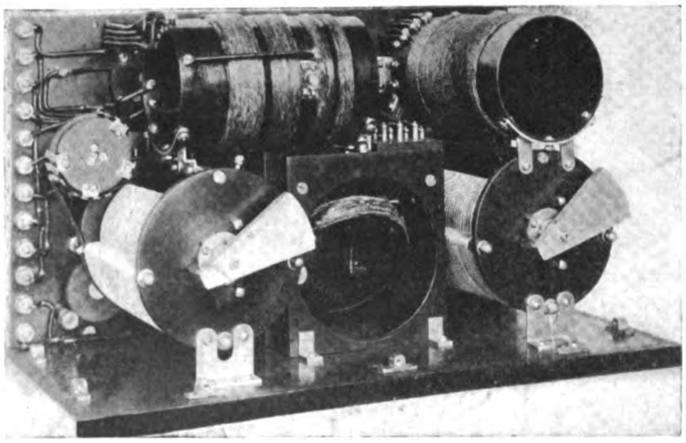


Figure 2—Rear view of receiver built by Marconi Co. for the U. S. Navy

Figures 1 and 2 show respectively the front and rear views of a CM 294C receiver, designed for the navy by the Marconi Wireless Telegraph Company, having a range of 250 to 3100 meters on an antenna of .0008 mfd. and 55 microhenries inductance—the ordinary navy antenna. In figure 3 is given the wiring diagram of the device, clearly showing each of the parts and their function in the circuit.

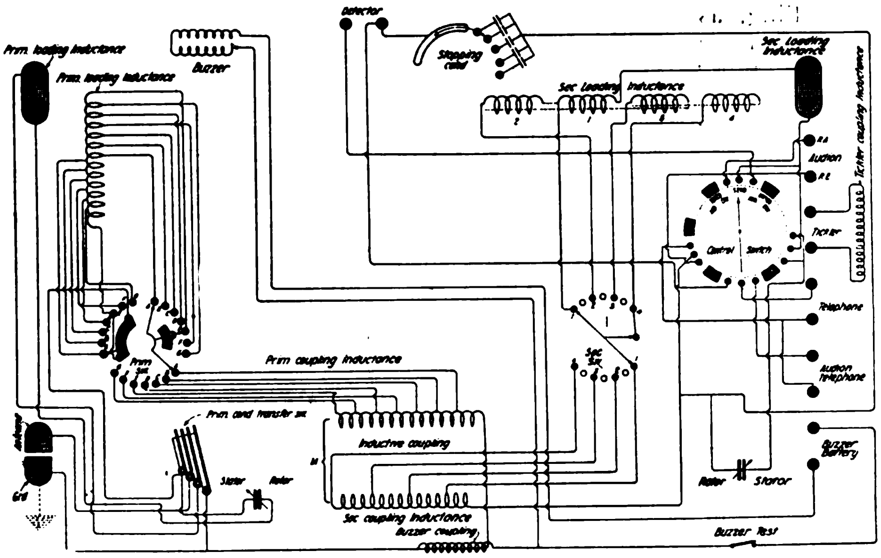


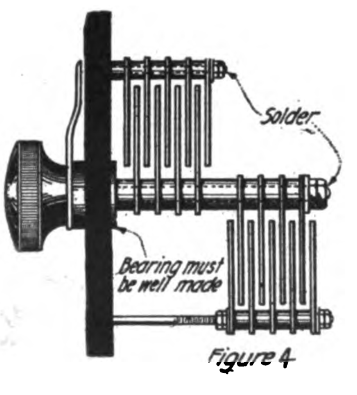
Figure 3—Wiring diagram of CM 294C receiver showing connections and function of each unit

A study of the front view, which is practically the standard layout, will show that the parts have been very logically arranged. Primary and secondary condensers are at the two sides and near the bottom, at just the right height for ease of manipulation by the operator, while the two and three point inductance switches for the secondary and primary coils are placed above their respective condensers, at a place demanded by their lesser usage. A neat feature of the design is that as the inductance switches are turned from point to point, the pointer shown above the condenser knob is automatically operated by a cam movement to the proper wavelength scale on the condenser dial. Further, these inductance switches are so arranged as to put the primary condenser either in series or in parallel with the primary loading coil as required by the setting. Coupling and tickler coupling in the center, and the other controls such as detector test, stopping condenser, etc., offer a logically useful layout and an extremely neat appearance. One more characteristic is the secondary fine adjustment device for tuning the secondary circuit accurately. This is really only a train of three gears driving the secondary condenser through an idler, the reduction being ten to one. The principal use of this device is to take care of small changes of condenser setting when tuning.

Figure 2 shows the details of the design. The fine adjustment gear and idler are clearly shown. The condenser, whose values are .0045 primary and .0032 secondary in the usual Class I design, are made of 5-inch diameter aluminum plates, 32 mils thick. The balanced plate type condenser, in which one-half the rotor plates are located on one side of the shaft and the other half on the other side, as shown in figure 4. was adopted as standard practice later. This idea by eliminating the heavy counter weight of the usual design, will reduce the cost of the amateur condenser.

Details of the inductance coils are noteworthy. The navy coils were invariably wound with Litzendraht on natural dilecto tubing 4 inches inside diameter and 4⅛ inches outside diameter, a saving in efficiency for the longer wave stations, say above 1000 meters. Below this value the litz is of little use. Primary and secondary tubes were nearly always located at right angles to prevent direct coupling from primary to secondary load. In some of the later sets it was found necessary to provide additional protection against this by placing a shielding partition between the two circuits. The secondary coil is wound in four distinct sections to cut down the distributed capacity of the coils.

There were two distinct classes of navy receivers. These were based on two different researches to obtain the best inductance resistance ratio for the coil. The first type was based on the idea that a high capacity and a small inductance would be the best. Hence all the first group of receivers had the characteristics outlined above. This assumption was found incorrect, as will be seen by a study of the decrement of a receiver circuit. It can be shown that for a given wave length, the decrement varies inversely as the cube root of the inductance. Hence the greater the inductance the less the decrement the receiver introduces. The second group of receivers were almost identical with the first group except the condensers, which were about one-quarter as large, and the inductance correspondingly larger. Coils were now made of No. 20-38 litz rather than the No. 3-16-38, which had been the previous practice. The amateur will find the former litz better than the latter. A great improvement was also made by building the detector valve directly into the receiver. When you consider that a foot of lead introduces disturbing capacities of the order of .000003 mfd, the advantage of this arrangement is clear. Careful shielding also was done. Best practice shows that complete shielding inside the receiver box with 1/16 inch soft copper, and shielding of the telephone cords with flexible copper braiding will give best results and prevent electrostatic couplings.



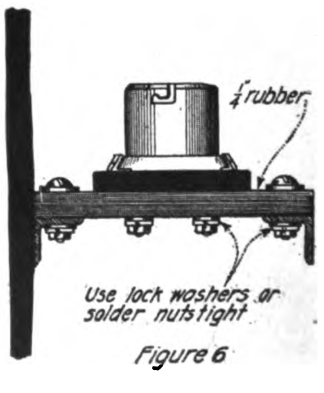


Figure 4—Balance plate type condenser
Figure 6—Shock-proof mounting for audio frequency tube

Let us now turn to the amplifiers the navy built, which in all cases were manufactured as units separate from the receiver. The type of circuit used—the ordinary transformer coupled—is shown in figure 5. At first air core transformers were used, but later, iron cored came into practice, and that is the best present day design. Two-mil carbon steel was found the best but three-mil silicon steel, which is a little less expensive, will give the amateur almost as good results for the radio frequency transformers. In the diagram shown, three radio frequency and three audio frequency amplifiers are assembled in one unit, each amplifier being shielded from the other. This makes expensive construction and should be avoided by the amateur, as the advantage over the method outlined above is very small. Another point for the amateur to remember who has a noisy and vibrating room to work in is that shockproof mountings are not needed for the radio frequency amplifier tubes. A good cheap shockproof mounting for the audio frequency tube is shown in figure 6. It consists of a sheet or several strips of rubber ¼ inch thick, mounted as shown. For a noisy place it will be found that an inductance of 100 microhenries inserted in series with the grid of the first tube will filter out extraneous noises. This was invented particularly for weeding out induction from the magneto on aeroplanes.

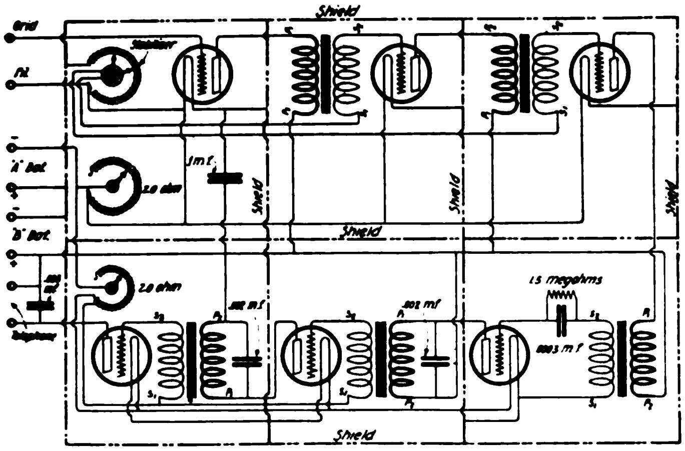


Figure 5—The ordinary transformer coupled type of circuit used

The navy added to the knowledge about transformers, particularly that each transformer gives best results at a given wave length. Below is a list of possible designs for you to try out. All coils are wound with No. 36 single silk enameled wire, on closed iron core transformers, sections of which are not exactly known, but which probably fill up the inside hole of the coil.

Primary or Sec.	Dimensions in inches Outside	Inside	Thick	Induc. (μhy)	Turns	Working Range (meters)	Best Point (meters)
Both	1.75	1.25	.22	19.5	800	2000-8000	5500
Both	1.75	1.25	.11	8.7	400	800-3200	1800
Both	1.05	.825	.11	.80	100	200-800	450
Prim.	1.75	1.25	.12	...	468	6000-24000	14000
Sec.	1.75	1.25	.24	...	830		
Prim.	Core	⅝" sq.	Gap .72"	...	170	300-1100	700
Sec.		.11" thick		...	190		

It is earnestly hoped that in the above outline, the reader may find sufficient information to try out some new apparatus for himself, and profit by the navy's experience.

The "Casey" Free Radio Schools

By William M. Bolger

Wanted—Any number of industrious ex-service men and women for a free scholarship in either elementary or vocational training by the Knights of Columbus. Must not object to sacrificing two hours each alternate evening; must be regular and consistent in attendance. To qualify must have served in army, navy or marine corps, army nurse service, or have an honorable discharge from War or Navy department. Apply to any Knights of Columbus council near your town or city. Courses free: wireless telegraphy, auto mechanics, acetylene welding, commercial law, English, arithmetic, stenography and typewriting, salesmanship, advertising, journalism, etc.

THE above invitation extended to former service men and women has been responded to by some 100,000 students who are now attending the chain of free evening schools under the auspices of "Casey" from the Canadian border to the cactus plains of Texas and from the bustling Atlantic seaboard across the continent to the Golden Gate and picturesque northwest. More than six and one-half millions of dollars have been laid aside to give the ex-service men and women an opportunity to make up for the time they lost in serving Uncle Sam in the World War.

The Knights have gone into the education business with a vim. William J. McGinley, the Supreme Secretary, and himself a "wireless fan," has decided to so develop this particular course that before next winter arrives the K. of C. will be able to transmit by relay wireless messages from New York to the Golden Gate, from Kansas to Texas, from Washington to Oregon and other far distant points.

The students of the San Francisco school recently sent out a message which was to be picked up along the route to New York City. Every station "listening in" reported afterwards the time and contents of the message, but on account of the low voltage they were not able to transmit any considerable distance. With the establishment of

Ex-service men attending the wireless class of the K. of C. school at Portland, Ore., one of twenty schools for free instruction of those who served with the colors several more radio schools where there is a distance of several hundred miles intervening, the K. of C. will be able to skip across the transcontinental aerial route and keep the schools testing the ability and progress of its individual student body.

J. F. Maher, radio instructor in the K. of C. school at Savannah, Ga., reports establishing direct communication with another experimental station in Washington, D. C., located at 1744 Corcoran street, and adds: "Every night we hear amateur stations as far north as Massachusetts, and west to Kansas."

The K. of C. schools will shortly be allowed, according to Mr. McGinley, to send a postal card to every amateur station whose call letter they pick up. In this way they will be able to render invaluable data to the amateurs throughout the country regarding the sending power of their apparatus.

The supplementary chain of evening schools were conceived at the Peace Convention of the K. of C. last August and within three months time had become a reality. A group of educators from various parts of the country constituted the committee which planned the nation-wide supplementary evening schools. In New York City the wireless school at 240 West 51st Street is never lacking in steady attendance. It has been in communication with the Boston school, another in Delaware, and has communicated with the steamships off Fire Island and other points adjacent to the harbor.

There are approximately twenty radio schools now located in different cities under the auspices of the Knights. An interesting sidelight on the attendance is the fact that many army nurses are taking the course. In a survey made of the radio schools it was found that they maintain a high record for attendance and that the students are deeply interested in their work which makes it less hard for the faculty.

Several of the teachers in the schools are men who formerly served with the signal corps of the Army and radio service of the Navy. In many of the schools the students spend the first hour with the wireless and second period with the class in electricity. With the resumption of the fall term of the K. of C. schools this autumn it is planned to have several more radio classes established and a complete relay service that will take in a radius of at least 2,500 miles.

A New Three - Electrode Vacuum Tube

A NOVEL type of three-electrode vacuum tube has been evolved by John Scott-Taggart. This tube differs from the usual pattern in that the grid takes the form of a metal plate close to the filament, while the anode, also in the form of a metal plate, is placed diametrically opposite and on the other side of the filament. The tube is illustrated in figure 1. The filament F is arranged vertically, the tube support being a nickel-iron spring which keeps the filament taut. The anode P is a small metal plate placed at a considerable distance from the filament. The control electrode which takes the place of a grid is in the form of a large metal plate G, situated within a few millimetres of the filament F. The curves in figure 2 were obtained with a vacuum tube which possesses the following dimensions:

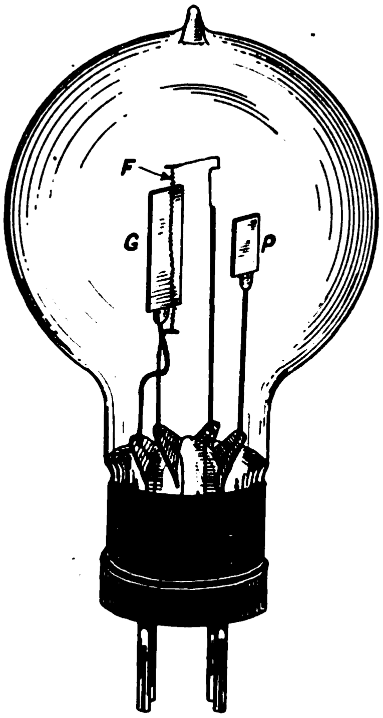


Figure 1—The new type of three-electrode tube

P plate 10 m/m x 10 m/m x 0.008" nickel sheet.
G plate 22 m/m x 10 m/m x 0.008" nickel sheet.
Filament F crimped 25 m/m x 2/3 mils tungsten wire.
Distance F to P, 9 m/m.
Distance F to G, 2 m/m.

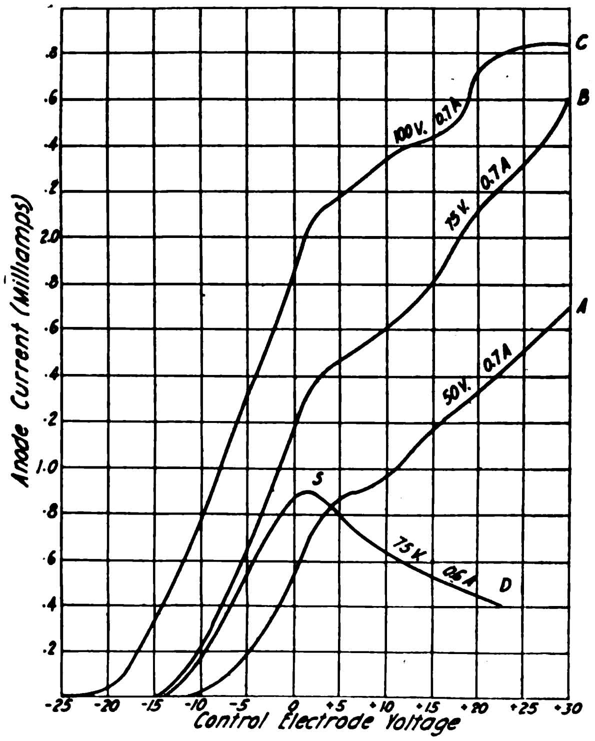


Figure 2—Graphic curves showing the operating characteristics of the tube

It will be seen from the curves that varying voltages on G will cause variations in the anode current to P, causing the tube to operate in a very similar manner to an ordinary three-electrode tube with the grid placed between the filament and plate. An increase of control potential causes an increase of anode current, and vice versa. It will be seen that parts of the curves lying to the left of the ordinate through zero potential on the control electrode are very regular and similar to those obtained with an ordinary vacuum tube. When, however, the control electrode is made positive with respect to the filament, it will be seen that the curves commence to lean over rapidly to the right. The electrode G is now drawing to itself an appreciable portion of the electrons emitted from the filament. The effect is far more marked than in the case of an ordinary vacuum tube, since the plate is a more suitable electrode for absorbing the electrons than a fine wire grid. To the right of the zero ordinate the curves become less regular when the control potentials reach higher positive values than those shown in curves A, B and C. The anode currents reach a saturation value and then begin to decrease. This effect is shown in figure 2 by the D curve, which corresponds to 75 volts on the anode and 0.6 amp. through the filament. The anode saturation current is reached at S. An increase of control potential now causes the anode current to drop, electrons which formerly went to the anode are now being drawn to the control electrode.

The same effect is obtainable with an ordinary vacuum tube, but the comparatively sharp bend at S is far more marked in the case of this special tube. This is explained by the fact that the control electrode is of such a nature as to absorb electrons very rapidly. From the curves it will be seen that the amplification obtainable is not as high as in the case of the more usual types of vacuum tubes, in which the grid is placed between the filament and anode. When tested on an actual amplifier, the results, however, are almost as good. The representative point should preferably move only along the negative portion of the curve.

The tube operates efficiently as a detector, the point S being specially suitable for strong signals, both half-oscillations producing decreases of anode current. The vacuum tube also operates excellently as an oscillator or self-heterodyne receiver with 100 volts on the anode and 6 volts across the filament.

No doubt the characteristics and general properties of the tube could be greatly improved by further research.

An Oscillating Current Generator

Lee De Forest has devised a high frequency generator which he claims is simple and efficient. With reference to the figures, 1 designates an evacuated vessel provided with two chambers which are united by a narrow passage 4. In these two chambers a mercury electrode or a mercury amalgam electrode is placed. A source of electromotive force, indicated at 7, supplies the current to the electrodes to heat them and causes a vapor arc column to form in passage 4. In chamber 3A, forming part of the evacuated vessel and communicating with the mercury arc passage, are located two cold electrodes, 9 and 10, arranged at different distances from the vapor arc column maintained in the vertical passage. The electrode 9 is electrically connected to one terminal of a source of emf. 11. Direct current is used for this purpose. The other terminal of this same source is connected to one of the cathode electrodes, for example, 5. The circuit connection between these two last mentioned electrodes also contains an "inertia" coil, as indicated at 12. The electrodes 9 and 10 must be kept cool. This may be accomplished in several ways. In the case of the electrode 9, a simple arrangement is shown wherein a reservoir which is provided with pipes opening upon the electrode 9 and adapted to allow a cooling medium such as air, water, etc., to circulate through it. The electrode 10 may be of any shape; in the illustration it is in the form of a bent hollow grid with extensions projecting out through the walls of the tube to allow the circulation of air or oil through it. The cooling medium may be supplied from the one reservoir, but for the sake of avoiding confusion in the drawing, this connection is not shown.

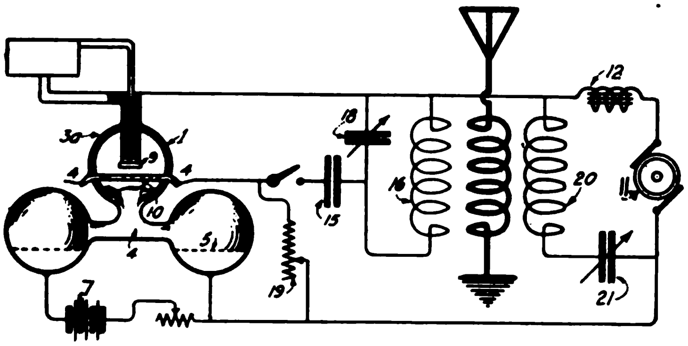
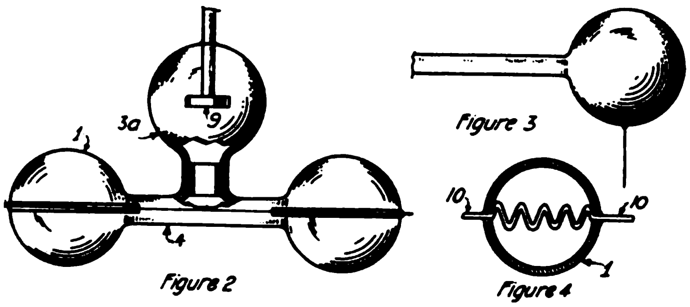


Figure 1—Circuit showing hook-up of the oscillating current generator



Figures 2, 3, 4—Details of the evacuated chambers, showing electrodes, passage for vapor arc column and hollow grid

An oscillating circuit is connected to the electrodes 9 and 10, the circuit consisting of a condenser and an inductance. A switch, or make-and-break device, is also placed in series with this oscillating circuit and its electrodes. A high resistance, 19, is also connected between the grid and the vapor arc column in the vertical passage to form a "leak" path between these electrodes, the purpose of this leak being to carry off the excess charge which may accumulate on the grid and thereby reduce the efficient operation of the oscillator.

DeForest finds that if a second oscillating circuit is established, which includes the electrode 9 and the vapor arc in the vertical passage, and an inductance and a condenser 20 and 21, all in series with each other, the oscillations set up in the original oscillating circuit are increased in intensity provided the period of the second circuit is made equal to that of the first. It is not essential, however, to use this second circuit, but when the two circuits are employed, they should be inductively coupled as shown.

An output circuit may also be associated, either inductively or conductively, with one or both of the circuits. In the arrangement shown, the output circuit is made up of a variable inductance connected between the radiating antenna and the earth in the usual way. The natural period of this output circuit should be equal to that of the first oscillating circuit.

DeForest states that he has as yet been unable to fully and completely understand the operation involved in a generator of the type described. He has found, however, that such an arrangement does operate as a generator of high frequency oscillations suitable for radio work, and whether correct or not, explains the phenomena involved as follows:

If the generator 11 is a direct current source, a negative current is set up across the oscillator by means of the thermions passing from the hot electrode (vapor arc in passage 4) to the cold electrode 9. A negative charge impressed upon the grid will greatly reduce the electron flow from the vapor arc to the cold electrode 9, or in other words, will increase the potential drop between the cold electrode and the hot electrode. Therefore, if the electrical connection between the grid and the plate, 9, be suddenly established by closing the make-and-break switch, the positive potential of the plate and of the positive terminal of condenser 18, will be suddenly increased. Further, any positive charge on the grid will be rapidly carried away by action of the negatively charged electrons from the hot electrode attached thereto, inasmuch as the capacity of the stopping condenser, 15, is small. Thus a difference in potential is quickly established between the two terminals of the condenser. The inductance coil, 16, prevents this difference of potential across the condenser from immediately equalizing, and in consequence, an oscillatory discharge is set up through the inductance. At the end of a half period of this discharge the potential of one terminal of the condenser is therefore reduced or made negative, while that on the other side is made positive relative thereto. The reduction of the positive potential at one terminal of the condenser and on the plate causes a sudden increase of positive current from the generator, which again charges one terminal of the condenser positively and again sets up a negative current across the coil to the other terminal of the condenser and to the grid. This inrush of negative charge to the grid will again reduce the electron flow from the hot electrode to the cold electrode, that is, will still further increase the positive potential of the plate and the corresponding terminal of the condenser with respect to the other terminal of the condenser. Thus the condenser will once more begin to discharge a positive current through the coil and the entire action as above described will be repeated, growing in intensity as it proceeds, due to the magnetic inertia of the coil, up to the point where the loses in the circuits and in the oscillator itself are equal to any further increase in the energy representing the oscillation.

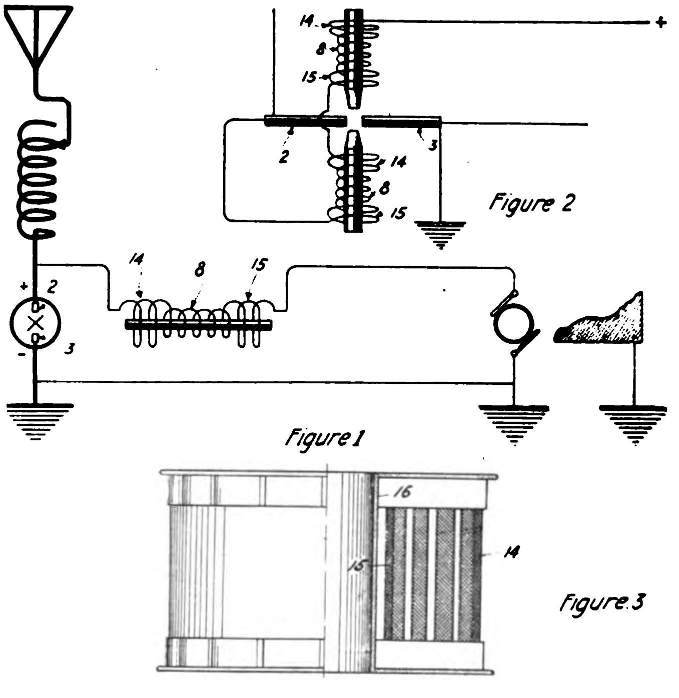
Improvements in Arc Generators

A PATENT recently issued to L. F. Fuller, covers the reduction in size, cost, and weight of an arc radio transmitter, and also provides a transmitter which has a D.C. generator which is safer to handle than the generators formerly used in arc transmitters. The Poulsen arc radio generator comprises a closed chamber containing an atmosphere of hydrogen in which are arranged electrodes between which the arc is formed. The arc gap is subject to a strong transverse magnetic field produced by field windings arranged in the D.C. circuit which supplies the arc. A choke coil is arranged in each arm of the circuit between the D.C. generator and the arc to prevent the high frequency oscillations produced by the arc from reaching the generator.

For purposes of coil insulation, it has always been considered essential to place the magnetic windings in the lead between the generator and the arc electrode, which is grounded. In this prior construction, it is inadvisable to ground the frame of the D.C. generator on account of the large inductive kick of the arc magnet winding which produces dangerous potential surges which, if the frame were grounded, would be impressed on the D.C. generator insulation, causing burn-outs. The generator frame has, therefore, always been insulated from the earth with the result that it frequently became highly charged, and therefore, a source of danger. Also, in the tropics, the material used for insulating the frame from earth, sometimes warps and shrinks, throwing the generator out of alignment with the prime mover. Fuller has found that by combining the choke and magnet coils and placing them in the lead which is connected to the antenna side of the arc and by grounding the generator side of the armature to the generator frame, that a better and cheaper construction is produced than was possible with the prior arrangement. Usually, but not necessarily, the negative lead is connected to the grounded side of the arc.

Figures 1, 2 and 3 are respectively a diagrammatic representation of Fuller's invention, a diagrammatic representation of a modified form of arc generator, and an elevation, half in section, of the combined magnetic and choke coils.

The oscillation generator of the invention comprises two electrodes, 2 and 3, between which the arc is formed, the electrode 2 being connected preferably to the positive side of the electric generation and to the antenna and the electrode 3 being connected preferably to the negative side of the generator and to the ground. The magnetizing winding, 8, is arranged in the lead between the generator and the electrode 2. This winding may be concentrated on one pole or may be placed on both poles, and when so placed, the winding may be in series as shown in figure 2, or they may be in parallel. The other lead connects the ground electrode directly with the armature of the generator and this side of the armature and the generator are grounded. Fuller has found it advantageous to combine the magnetic winding and the choke coil in one winding. That end of the combined winding which is connected to the electrode 2 is constructed so as to serve as the choke coil and since it is often impossible to determine in advance which end of the coil will be connected to the electrode on account of various features of installation, he prefers to form choke coils 14 and 15, at each end of the combined coil. The turns of the winding nearest the electrode are subject to higher duty than the inner turns of the coil and outer turns 14 and 15 are more heavily insulated than the inner turns. The end turns of both ends of the coil are covered with increased insulation for the reason stated before, but when it its definitely known which end of the coil is to be connected to the electrode, the turns on that end only, will be provided with heavier insulation.



Figures 1, 2, 3—Wiring circuit, arc generator and the combined magnetic and choke coils respectively

The combined coil is built up on a spool, 16, within which the magnet pole is arranged.

A New Variable Condenser

A NEW method of condenser construction is disclosed in a patent recently issued to Robert J. Fitzgerald. The main object of his invention is to provide more efficient and more easily applied insulation for the condenser plates and as an important feature of the invention, he coats the various conducting elements with a non-conducting film, permanently deposited thereon and enveloping the conductor. This non-conducting film or jacket is of such a character that it is not affected by the temperature, chemical or electric conditions with which the condenser is subjected. As an example of such a film, an enamel composition of such character that it may be backed onto the plates may be employed.

In the accompanying drawings, one embodiment of the invention is illustrated on a large scale so far as the thickness of certain parts is concerned, in order to facilitate illustration. Figure 1 is an inverted plan view. Figure 2 is a section of the line 2-2 of figure 1. Figure 3 is an enlarged view of one of the elements.

In the form shown, the condenser is mounted on a slab of any suitable non-conducting material. Several stationary condenser plates of semi-circular form are rigidly secured to this slab by connecting bolts or other suitable means and the plates are held in spaced relationship by spacers. The single rod 15 extends through the plates approximately at the center of the curvature and is positioned at the center of the curvature of the stationary plates, which are shown as cut away midway of the straight line, to form a recess receiving the shaft as is the usual apparatus.

By means of this invention, the use of separate insulation plates is avoided. Each plate carries its own insulation and in case of the breakage of insulation of any plate, the plate may be readily removed and replaced by a new one.

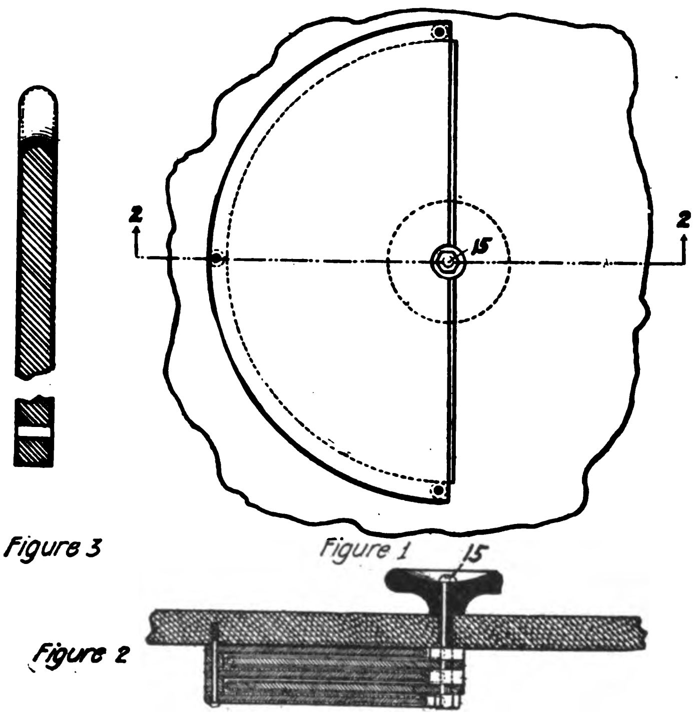


Figure 3

Figure 1

Figure 2

Figures 1, 2, 3—Details of the variable condensers

Condenser Construction

IN THE construction of condensers where solid dielectric is used, intimate contact between the surfaces of the conducting plates and the insulating sheets is highly desirable. If there are spaces present between the conducting sheets and the dielectric, the capacity of the condenser is cut down owing to the larger distances between the plates and the capacity of different elements varies because of the irregularity of such spaces. Furthermore, the dielectric medium lacks uniformity since it consists at some points solely of mica and at other points of mica and air, or impregnating compound, if the latter be employed.

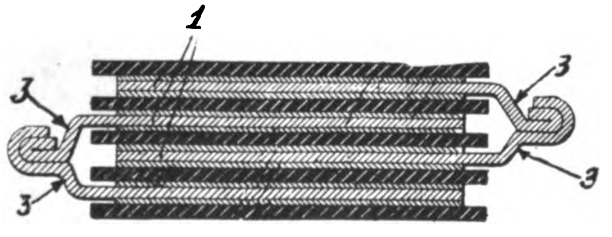


Figure 1—Assembly of the conducting and dielectric plates

In figure 1, William Dubilier shows a method whereby the inconvenience above mentioned may be avoided. Between the hard conducting plates 3, and the dielectric plates 1, are interposed conducting plates made of soft foil. The assembly is then subjected to an extremely high pressure of the order of several thousand pounds, with the result that the faces of the conducting plates and insulating sheets are intimately connected and brought into absolute union, with each other; for instance, if mica be employed as a dielectric, its hairy and minutely irregular surface will be imbedded into absolute union with the conducting plates so as to eliminate any small voids or spaces between the same; that is, the soft foil works itself into the depressions of the mica sheet at the same time maintaining perfect connection with the hard copper conducting sheet, 3.

Dubilier also shows his method of adjusting fixed condensers in order that they may have a predetermined capacity value. Figure 2 shows condenser sections set up and connected in series in order to form a condenser which will withstand high electromotive forces. Heretofore, condensers made of a large number of conducting plates and insulating sheets have been tested after being completed, and the capacity adjusted, by tearing off or adding the required number of insulating sheets and conducting plates to bring the capacity within the necessary limits. After adjusting the capacity in this way, there is a certain amount of "patch work" on each condenser, which is obviously undesirable, and it is necessary to change the terminal connections of the conducting plates in order to accommodate a greater or smaller number, as may be required. In some instances, condensers made up of several condenser sections have been employed, each of such sections consisting of a number of conducting plates and insulating sheets bound together and the terminals of the sections connected in series or in parallel to make up the complete condenser. The capacity of condensers of this latter type has been brought within desired limits by tearing off or building on the necessary number of conducting plates and insulating sheets to the last section. This practice is open to the same objections as above mentioned and also to the further disadvantage that the removal of conducting plates from the last or end section may reduce the area or effective surface of the latter to such an extent as to give a breakdown in that section. In condensers where high potentials are to be withstood, it is desirable to distribute the potential over a large number of condenser sections in order that no single section may be subjected to undue stress. Figure 2 shows a condenser of the last mentioned type in which the disadvantages heretofore encountered in making capacity adjustment are avoided. In making up a condenser of any desired capacity, several sections are built up and the individual capacity of each section is made of such value that when approximately the number of sections necessary to provide a complete condenser of approximately the desired capacity, are connected, the addition or withdrawal of a section from the complete condenser will produce a change in the capacity of the condenser less than the permissible error. In other words, when about the proper number of sections have been connected, the capacity of the complete condenser is tested and one or more sections added on or removed, as may be necessary.

Since the capacity of the sections has been so chosen that when the approximate desired capacity has been reached, the addition or removal of a section will produce a change in capacity well within the permissible variation from standard. It is also possible to bring the capacity of the condenser to a value within the prescribed limits in the above manner.

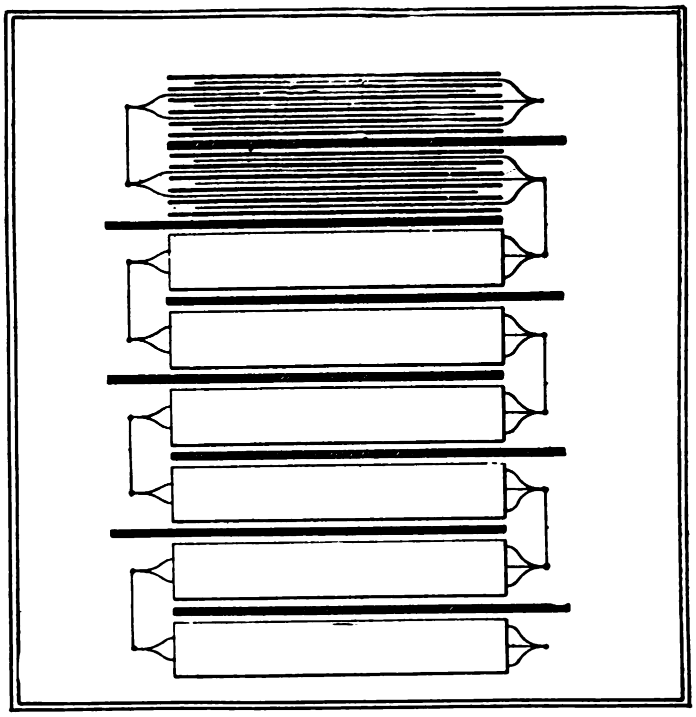


Figure 2—Condenser sections set up and connected in series

Controlling the Amplitude of Radio Frequency Continuous Oscillations

It has been found that an electron discharge device comprising an incandescent cathode, a co-operating anode, and a discharge controlling member of the grid inclosed in an evacuated envelop may be employed for producing radio frequency oscillations. In order to secure this result a source of energy is placed in the plate circuit of the device, which includes the cathode, the anode, and an inductance, and this circuit is coupled with the grid circuit, which includes the cathode and grid, and a second inductance. If a suitable degree of coupling is provided between the two circuits enough energy is transferred from the plate circuit to the grid circuit to impress upon the grid the potential necessary to control the flow of current in the plate circuit in the desired manner. In some cases the electrostatic coupling betwen the two circuits, which is always present by reason of the capacity between the electrodes, is sufficient to bring about the desired result. In other cases this is supplemented in various ways, as, for example, by a coupling between the inductances in the two circuits, or by an additional electrostatic coupling consisting of a condenser between the grid and anode, or by a combination of the two forms of coupling. Because of the unidirectional conductivity of the electron discharge device, the current in the plate circuit will usually be pulsating in character. For practical purposes, however, it may be considered as being made up of two components, one a constant direct current, and the second an alternating current superimposed upon the direct current. In order to utilize this alternating component in a radiating system it has been customary to couple a coil in the antenna with the plate circuit inductance. It has also been customary to employ variable condensers in the plate or grid circuits, or in both circuits, for tuning the system to produce the desired frequency of oscillations. With the systems heretofore employed, in order to secure maximum efficiency of output, it has also been necessary that the antenna should be tuned to the same frequency as the system which produces the oscillations.

Dr. A. N. Goldsmith provides a system in which the entire tuning may be accomplished by varying one of the constants of the antenna, and in which the necessity of an inductive coupling between the antenna and the system producing oscillations is avoided. In accomplishing this object the grid and plate circuit inductances are included directly in the antenna, and the capacity of the antenna is made use of in place of the condensers previously employed for tuning the grid or plate circuits.

In case it is desired to utilize the radio frequency oscillations produced by the electron discharge device for the transmission of sound waves, it has been proposed to superimpose upon the grid circuit of the device a variable current produced by means of the sound waves which it is desired to transmit. With this arrangement the degree of control which can be secured is limited to some extent by the amount of energy which can be controlled by an ordinary telephone transmitter. Hence it will be apparent that if means are provided for amplifying the current variations produced by the telephone transmitter a larger degree of control may be secured. A further object of this arrangement is to provide simple and efficient means for amplifying the audio frequency current produced by the telephone transmitter. In accomplishing this an audio frequency coupling is used between the grid and plate circuits. When the telephone current is superimposed upon the grid circuit corresponding but amplified variations are produced in the current in the plate circuit. These amplified current variations are, by means of the audio frequency coupling fed back into the grid circuit, and as a result of the audio frequency potential variations upon the grid are made much greater than it is possible to secure by means of the original telephone current alone.

As indicated in the drawing, an electron discharge device is used which comprises an electron emitting cathode of filamentary form, a plate-shaped anode, and a grid interposed between the cathode and the anode, all inclosed in an evacuated envelop. The plate circuit of this device includes the cathode, anode and inductance and a direct current generator. Current for heating the cathode to cause it to omit electrons is supplied by a battery, the means for regulating the heating current which is customarily used being omitted in order to simplify the drawing. The grid circuit comprises the cathode, grid, an inductance and coils 9 and 10 of transformers adapted to the transformation of audio frequency currents, for example, the iron core transformers 11 and 12. The antenna may be connected to the top of the inductance through a tuning coil or directly connected to the top of coil, depending upon the antenna characteristics, and the radiating system is grounded through inductances 8 and 5. With the connection thus far described the grid and plate circuits are coupled electrostatically by reason of the capacity between the electrodes and this coupling is supplemented by the capacity of the antenna which is in effect connected between the grid and anode. The relative positions of coils 5 and 8 may also be made such as to furnish any desired degree of inductive coupling between the two circuits.

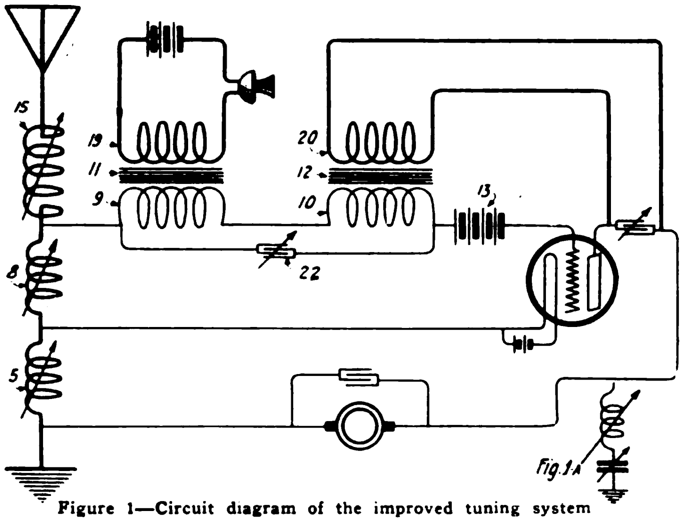


Figure 1—Circuit diagram of the improved tuning system

It is desirable to have the effective impedance in the output circuit of an oscillation discharge device, or several such devices in parallel or series, equivalent to the net internal impedance, which is mostly resistance, of such device or devices. This requires the introduction of the antenna reactance and resistance into the oscillating circuit with a transformer ratio which is, in general different from unity so as to obtain the most efficient operation. The coil 15 provides such a means of varying the ratio of transformation whereby the antenna reactance and resistance are introduced into the oscillating circuit, and a condenser in the antenna circuit, usually in the ground lead, would provide a similar means of adjustment though in the opposite sense.

The arrangement thus described is adapted to produce radio frequency continuous oscillations, the frequency of which may be varied by varying the tuning of the system by means of the tuning coil. The tuning of the system may also be varied by varying the inductance of coil 8 or coil 5, or, if desired, a variable condenser may be connected between the bottom of coil 5 and ground as shown in figure 1A. It will also be apparent that the desired result may be obtained by varying any two or more of the above-mentioned elements. In order to control the amplitude of the oscillations thus produced in accordance with the amplitude of the current produced by sound waves, current from the telephone transmitter supplied by a local battery is caused to flow through the primary of the transformer 11. When the transmitter is acted upon by sound waves, a variable telephone current will flow through the primary of the transformer. The potential of the grid is thus caused to vary in accordance with variations in the telephone current and the amplitude of the oscillations produced in the antenna will thereby be varied in accordance with the variations in the current through the transmitter. The current in the plate circuit will vary in the same way. This current will now have in addition to the radio frequency component an audio frequency component which varies in accordance with the variations in the telephone current, and this component is caused to flow through the primary of transformer 12, and is thus superimposed upon the grid circuit causing a further increase in the amplitude of the audio frequency potential variations upon the grid, provided the coils 19, 9, 20 and 10, are connected in such a way as to give the proper polarity to secure the reinforcing action. The condenser in the plate circuit which shunts the primary 20 is given such a value that it offers a low impedance to the radio frequency component of the plate circuit by a high impedance to the audio frequency component. The condenser which shunts secondaries of transformers 11 and 12 is also given such a value that it offers a low impedance path to the radio frequency component of the current in the grid circuit. The condenser may be employed for shunting the source of current in order that the radio frequency component of current in the plate circuit will not be compelled to pass through this source.

In the arrangement shown in figure 2, a plurality of electron discharge devices connected in parallel are employed for producing oscillations, the cathodes of all of these devices being supplied with heating current by common battery. In this case the source of current instead of being connected in series in the plate circuit is connected in the parallel branch, and an inductance is employed to prevent the radio frequency component of the plate current from flowing through the source and to insure efficient production of radio frequency energy. The coil 25 acts as a maintaining inductance in that it gives rise to radio frequency potential differences at its terminals. The result is that the plate circuit voltage of the electron discharge device, that is, the voltage between filament and plate, is variable with a radio frequency component. Because of the phase of the grid potential control, the voltage is highest when the internal resistance in the bulb is highest between plate and filament, and the external voltage is least when the energy is absorbed per cycle in the discharge device, and increased efficiency results. The condenser in the second branch of the plate circuit serves to prevent the direct current component of the plate current from flowing through this branch. In this case separate condensers 27 and 28 are employed for shunting the coils 9 and 10 instead of the single condenser 22.

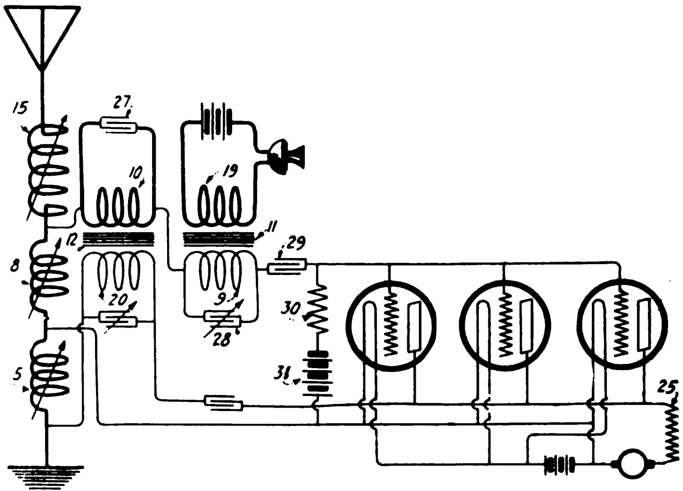


Figure 2—Modified form using three tubes

An Improved Arc Generator

G. M. MACKAY discloses an invention which comprises an apparatus for producing high frequency electrical oscillations from either D.C. or low frequency A.C. The object of this invention is to provide a means for generating oscillations which is of greater stability than arc oscillations heretofore used, and to generate high frequency waves which are substantially free from harmonics and of relatively large power. The electrodes being practically non-consuming and not being brought into contact when the arc is started, the arc gap may be accurately and permanently fixed. The apparatus embodying this invention comprises an oscillating circuit containing electrodes, one of which consists of refractory material operable at incandescence above 2000° C. in a gas substantially inert with respect to the incandescent electrode and at a pressure high enough to suppress electrical disintegration of the electrode.

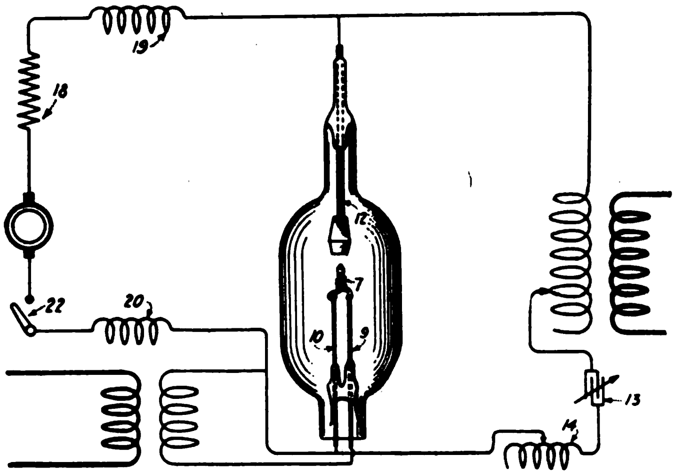


Figure 1—The arc generator and diagram of connections

Figure 1 shows the device with a diagram of electrical connections, and figure 2 shows a modification in which the arc of the oscillator is subjected to a magnetic field. Referring to figure 1, the arc is produced between a cathode and an anode connected to a source of energy. The cathode comprises a coiled conductor and a more massive, pointed arcing tip which is located close to and in good thermal relation with the coiled conductor 7. The cathode consists preferably of ductile tungsten or tantalum. A heating current may be carried to the cathode by the conductors 9 and 10, which may also consist of tungsten and which are sealed in the usual way into the stem. The anode and its supporting stem 12 preferably consist of tungsten but various conductive materials may be used, such as carbon, copper, iron, or other metals. The anode should preferably have a heat distributing capacity large enough to enable it to operate continuously below the temperature at which appreciable electron emission occurs, say, about 700 or 800° C. The envelop after having been evacuated of air and deprived of water vapor, is filled with a dry gas having little or no chemical affinity for the electrode material when at the operating temperature, such as hydrogen gas in which the arc drop or voltage consumption is relatively high, or various other gases, for example, nitrogen, carbon, monoxid, argon, meon, mercury vapor, or mixtures of the above, may be used. When using mercury vapor, the size and heat dissipating capacity of the envelop should be adjusted to keep the envelop at a temperature high enough to maintain the mercury vapor at the desired pressure.

The high pressure of the gas may vary within wide limits, but should in all events, be high enough to suppress electrical disintegration of the electrodes. Ordinarily the gaseous pressure should be materially in excess of about 50 millimeters of mercury, and preferably high enough to cause most of the energy supply by the arc to be expended in the gas. Pressures of about ⅔ of an atmosphere have been used with good success where the envelop was at room temperature. Pressures much above atmospheric pressure endanger the envelop particularly when the gas is subject to variable heating.

Connected in shunt with the arc is a resonant circuit containing an adjustable condenser and an adjustable inductance coil 13 and 14. There is included also in this circuit the primary coil of a transformer loosely coupled with a coil which feeds a consumption circuit. The energy supply circuit also contains a resistance 18 and inductances 19 and 20.

When starting the device, the cathode is first heated from any convenient source, as for example a transformer. The switch 22 may then be closed and an arc will pass between the electrodes. The heating current may be cut off when the cathode is at incandescence and the arc will continue to pass from the arcing tip to the anode, thus the necessity of bringing the electrodes into contact is avoided. No wandering of the arc over the cathode occurs with the described construction, thereby insuring regularity in the oscillations. By proper adjustment of the capacity and inductance in the oscillation circuit, a desired high frequency current may be obtained. For example with a gap of about ½ millimeter in hydrogen at about atmospheric pressure an arc has been started in this manner between tungtsen electrodes at about 250 volts which continues to operate with about 50 volts arc drop. With a .05 mfd. capacity and .5 millihenries inductance in shunt with the arc, a current of about 8 amperes was obtained in the oscillation circuit with a frequency of about 32000.

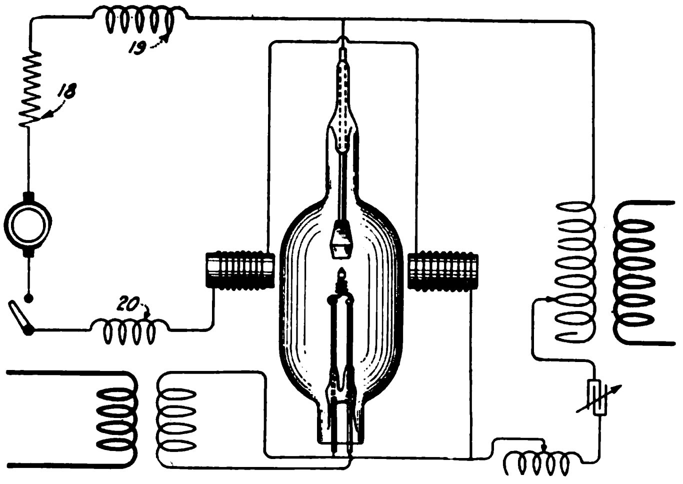


Figure 2—A modification in which the arc of the oscillator is subjected to a magnetic field

As both the cathode and the anode are substantially non-consuming and as the electrodes are permanently located in the device in a fixed position with respect to each other, the length of the spark gap remains constant during the operation of the device. When coupled to an antenna circuit in the usual way, frequencies of 1000 or higher have been obtained with a current of 8 amperes, which is especially suitable for telephonic communication. The distance between the electrodes may be varied with the supply voltage, for example, with a potential of 750 volts the gap may be 6 or 7 millimeters in length. In some cases, greater efficiencies may be obtained by applying to the arc a transverse magnetic field as illustrated in figure 2. The field may be generated by a winding located opposite the arc gap in series with the generator.

A Vacuum-Tube Trigger Relay

By J. Scott-Taggart

W. H. ECCLES and F. W. Jordan have recently described a method whereby two three-electrode vacuum tubes may be employed for the purpose of obtaining a trigger relay effect. The electrical current from outside which it is desired to detect and magnify is applied in the grid circuit of the first tube so as to make it momentarily more positive with respect to the filament. This results in an increase of current of the plate circuit of the first vacuum tube and consequently an increase of the potential difference across the plate circuit resistance R-1 which may conveniently have a value of 22,000 ohms, the value of H-1 being 78 volts. This increased potential difference is applied to the grid of the second tube, in the grid circuit of which is a battery B-1 of 31 volts which is intended to maintain the grid potential of the second tube in the neighborhood of zero volts. The negative voltage passed on to the grid of the second tube causes a decrease in the plate circuit of the second tube which contains the battery H-2 of 74 volts and the resistance R-2 of 12,000 ohms. The decrease of the plate current of the second tube will result in a pulse of positive potential being applied to the grid of the first tube. This magnified pulse will assist the potential already momentarily applied to the grid, and the result of this regenerative effect will be to cause a large increase in the plate current through the micro-ammeter M, included in the plate circuit of the first tube. This condition persists after the disappearance of the initial momentary potential applied to the grid of the first tube from the external source.

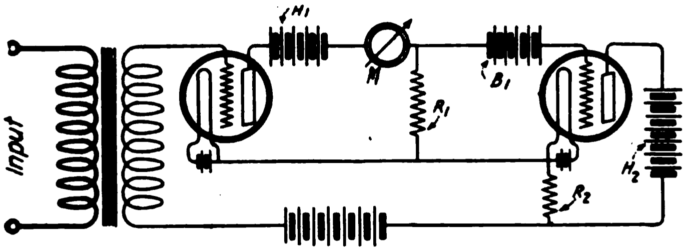


Figure 1—Wiring diagram of the vacuum tube trigger relay

The plate current of the first tube is normally made very small, and that of the second tube large, if the reception of the incoming potential plate current of the first tube is large and that of the second tube small. The device, therefore, acts as a trigger relay and it is necessary to restore the normal condition by cancelling the regenerative effect for an instant. The micro-ammeter M may be replaced by a moving tongue relay, using batteries and resistance of the value given, the change in the indication of the micro-ammeter M is from 0 to 2.5 micro amperes. The iron-core input transformer is of the ordinary pattern. It is stated that by connecting a pair of telephones across the primary of the input transformer the relay is operated with certainty by snapping the thumb and finger at a distance of 5 feet from the telephones, which act microphonically.

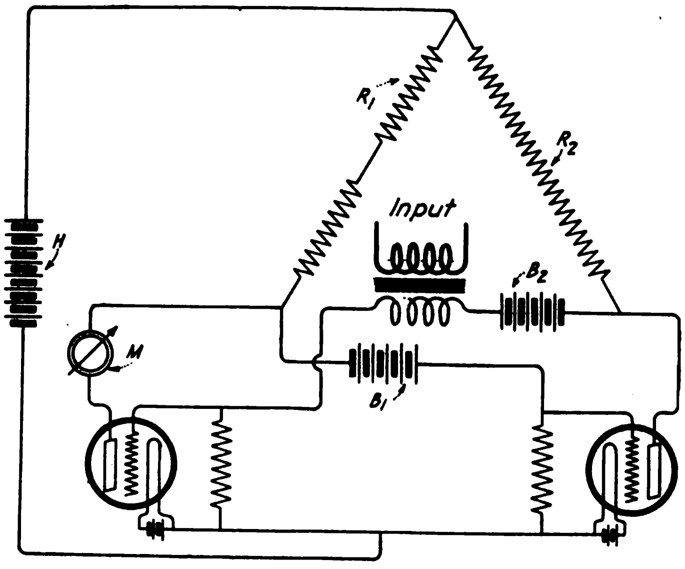


Figure 2—Another method of connecting the two tubes

Figure 2 shows another method of connecting the two tubes. In this circuit, the values of R-1 and R-2 are 100,000 ohms, while B-1 and B-2 have a value of 40 volts. The battery H has a value of 80 volts. Grid leaks of several megohms are connected as shown across grid and filament of each vacuum tube.

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Views of readers on subjects and specific problems they would like to have discussed in this department will be appreciated by the Editor

Construction of a Simple Wavemeter, Range 150-500 Meters

By A. H. Rice Jr.

THE construction of a wavemeter of efficient design is so simple and the benefits to be derived from its use so numerous, that the writer feels that the small expense involved in making one is more than justified.

There are probably two reasons why a wavemeter is not a part of every experimenter's equipment; first, the bugbear of having it calibrated; and, second, the extravagance of possessing an idle condenser. Both of these objections have here been eliminated and if directions are followed carefully, an accuracy within 5% may be obtained without calibration, which is sufficient for practical work, and the condenser, when not being used for measurements, may be placed in any part of the receiving circuit.

A wavemeter consists essentially of an inductance of known value and a variable capacity. A Murdock No. A366 condenser, having 43 plates and a maximum of .001 mfd. capacity was selected, as they have been found to be uniform in construction and are very reasonable in price. The corresponding wavelengths for the various settings of the condenser may be calibrated directly on a celluloid scale and this, in turn, may be fastened to the condenser or they may be plotted in curve form. In order to simplify construction, the latter method has been chosen, see figure 5.

The inductance may be wound on a mailing tube having an outside diameter of 5 inches and about 2 inches long, although, if there is a lathe handy a wooden ring of these dimensions will result in a much better looking coil. Nineteen turns of No. 20 SSC wire are necessary, the winding covering a space of about ¾ inches. Small binding posts should be mounted at each end of the coil, as indicated in the diagram, to which the terminals should be carefully soldered. The tube should be dipped in shellac and dried out to prevent shrinkage, but no shellac should be placed over the winding.

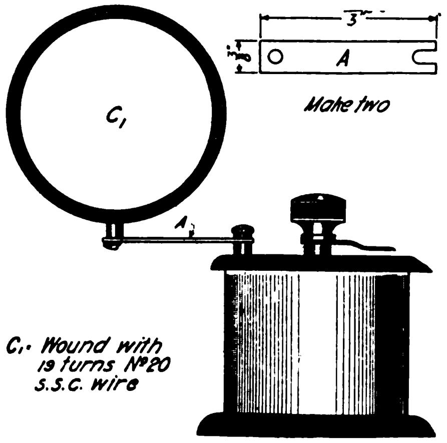
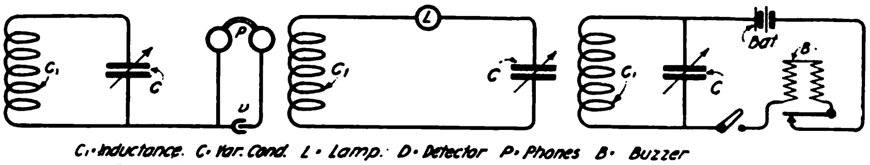


Figure 4—Showing the coil connected to condenser



C1-Inductance C-Var. Cond. L-Lamp D-Detector P-Phones B-Buzzer

Figure 1 Figure 2 Figure 3

Figures 1, 2, 3—Connections required for various measurements

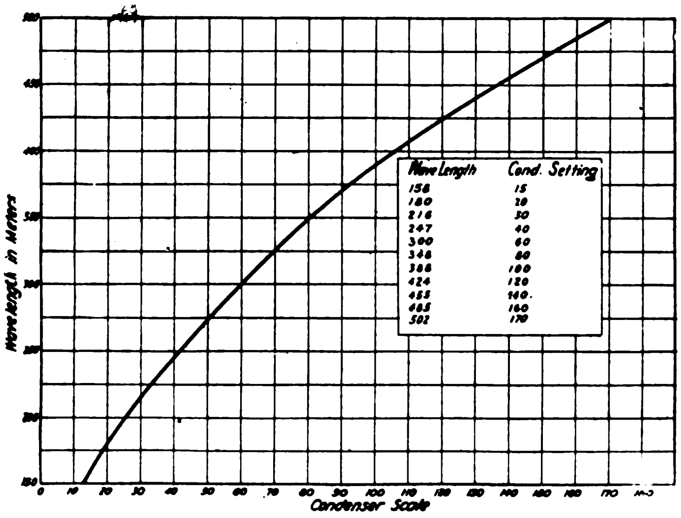
In addition to the inductance and capacity, a buzzer, small flash light bulb and mineral detector are necessary; the bulb and detector are used for ascertaining the maximum efficiency of the transmitter or the wavelength of an incoming signal and the buzzer is used as a transmitter to generate oscillations of known wavelength.

In connecting up the meter, the experimenter is advised to make all connections as short and direct as possible with No. 16 bare copper wire, excepting those from the coil to the condenser, which should be made of strip brass 1/16 inch thick, see figure 4.

Figures 1, 2 and 3 show the connections required for various measurements and particular attention is called to the fact that in figure 1, the phones are not connected across the condenser, for if this were the case, their additional capacity would require a re-calibration of the meter.

No effort will be made to burden the reader with instructions on the various methods of using the wavemeter, as this has been fully covered in several complete works on the subject and in many of the current magazines.

Reference to the diagram will disclose any details which may have been omitted in this description. All of the apparatus may be mounted on a panel and placed in a cabinet for convenience if desired, but unless the reader is an expert at woodworking, he is urgently advised to turn this job over to his cabinetmaker, as careful workmanship here will make the wavemeter a "thing of beauty and a joy forever."



Wave Length	Cond. Setting
158	15
180	20
216	30
247	40
300	60
348	80
388	100
424	120
455	140.
485	160
502	170

Figure 5—Graphic curve and chart showing various calibrations

Wind Your Own Honeycomb Coils

By C. J. Fitch

THERE is no doubt that honeycomb coils are the most practical inductance coils that the amateur can find. The price of a complete set of coils including the coil mounting is, however, beyond the reach of many experimenters. The obvious remedy is to wind your own honeycomb coils.

The experimenter who tries to wind these coils by hand usually fails, because each turn being wound diagonally around a cylinder is oval shaped and tends to straighten out to a circle, taking the shortest path around the cylinder. As a result the winding collapses. To prevent this, the wire must be wound on a form so shaped that each turn is already around the shortest path of the form. The form, therefore, must be spherical in shape; then each turn, no matter which direction it is wound, will not shrink to a smaller size and loosen the whole winding. This not only facilitates the winding, but makes a better coil mechanically and electrically. Mechanically, the coil is self-supporting and will stay as wound when removed from the form. If given a coat of shellac, the coil is very strong, and can be used for many purposes, as for variometers, wavemeters, etc. Electrically, the coils have a greater inductance than those wound on a cylinder with the same amount of wire.

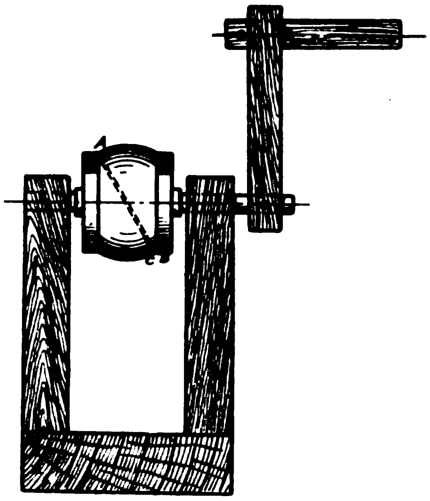


Figure 1—Machine for winding honeycomb coils

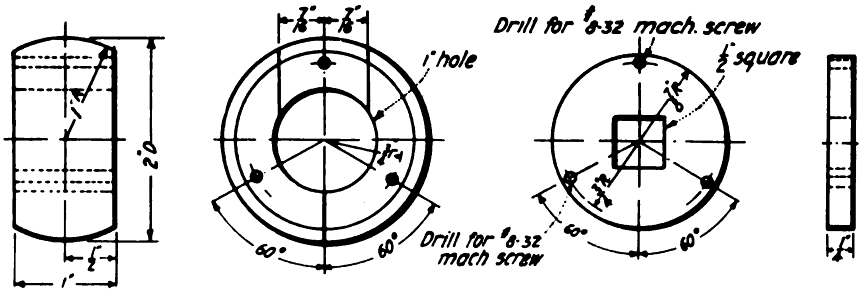


Figure 2—Constructional details of the arbor

Figure 1 shows a machine for winding honeycomb coils which anyone can build. The entire machine is made of wood.

Figure 2 shows the details of the arbor. It can be cut out of a piece of soft wood with a knife and sandpapered smooth or turned out on a lathe.

To wind a coil, first fasten the machine securely to a bench or table. Clamp the end of the wire under the end plate at A, figure 1, and wind diagonally across the arbor to B, as shown by the dotted line. From B, wind around to A, cross over the first turn at A and wind onto C. Continue in this way, spacing the turns about 1/16" apart, till the winding is complete. Then remove the coil and apply a coat of white shellac.

The writer has wound several coils in this way as easily as a single layer cylindrical coil could be wound, and they have an appearance equal to machine wound coils.

Figure 3 shows the method of mounting the coils on a panel so that they can be swung back and forth on hinges to vary the coupling. Two coils should be hinged to the panel and a third coil fastened stationary to the panel between the hinged coils. One hinged coil is the primary, the middle coil the secondary, and the third coil the tickler coil, for the regenerative circuit.

As shown on the drawing, the clips are arranged so that a coil can easily be removed, and another coil inserted in its place.

The following gives winding data for a set of coils suitable for the average amateur station:

No. of Coils	No. of Layers of Wire	Size of Wire
2	2	24
2	4	24
2	6	24
2	10	26
2	14	26
1	18	26
1	22	28
1	26	28
1	30	28

Tuning is accomplished with variometers or variable condensers. With a primary condenser of .001 mfd. and a secondary condenser of .0005 mfd., a wide range of wavelengths can be covered.

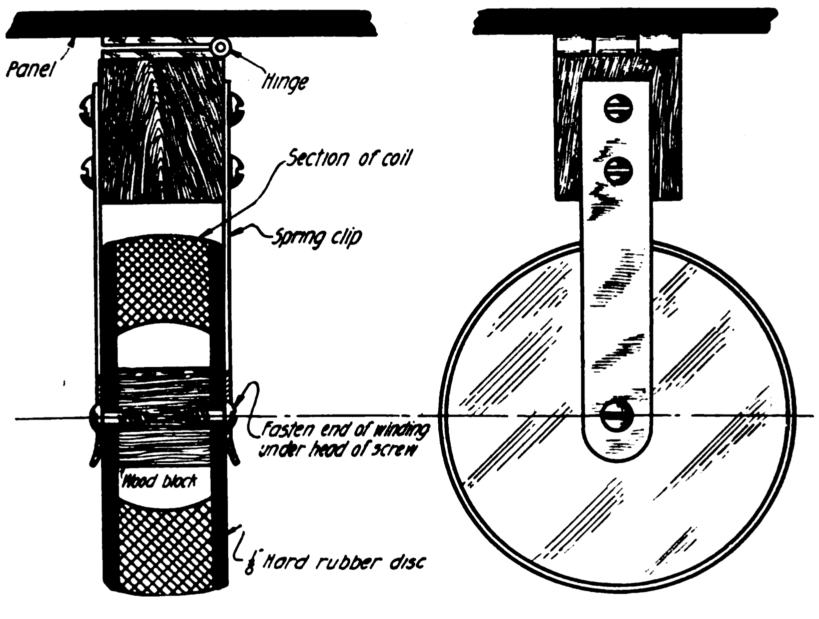


Figure 3—Method of mounting the coils

Second District Call Letters of Amateur Stations

Letters.	Power.	Name and address.
2AA	18	Vincent J. Fritch, 939 College Ave., New York City.
2AB	1000	M. W. Sterns, 129 Wadsworth Ave., New York City.
2AC	50	Chester R. Gernert, 41 Bridge St., Somerville, N. J.
2AD	45	Theo. N. Whildin, Oakdale, Long Island, N. Y.
2AE	80	Wm. H. Hoppi, 365 Quincy St., Brooklyn.
2AF	500	Benj. Berlin, 1252 Flatbush Ave., Brooklyn, N. Y.
2AG	25	Howard Terry, 25 Myrtle Ave, Keyport, N. J.
2AH	500	A. Edelman, 956 Legett Ave., New York City.
2AI	50	John G. Eber, 5505 Third Ave., Brooklyn.
2AJ	40	Edwin T. Buttner, 1376 Third Ave., New York City.
2AK	500	Carl J. Hunkins, Johnson Ave., Newark, New Jersey.
2AL	36	Walter N. Stanley, 451 Hancock St., Brooklyn.
2AM	250	Henry L. Bantelman, Jr., Tuckahoe Rd., Yonkers, N. Y.
2AN	250	Conrad J. Sedlak, 633 Main St., North Bergen, N. J.
2AO	1000	Robert J. Freeman, Aloah Rdo. Sta., Southampton, N. Y.
2AP	500	C. F. Unger, Franklin Ave., Harrison, N. Y.
2AQ	25	Harry Blutstein, 723 Stone Ave., Brooklyn.
2AR	500	G. H. Underhill, 78 S. Hamilton St., Poughkeepsie, N. Y.
2AS	220	Harvey Kennedy, 1965 Vyse Ave., New York City.
2AT	15	Herman Fischer, Jr., 146 Myrtle Ave., Irvington, N. J.
2AU	220	Chas. J. Huff, 1972 Honeywell Ave., New York City.
2AV	250	Frank S. LeRoy, 103 So. Maple Ave., Ridgewood, N. J.
2AW	14	Arthur A. Heberlein, 768 Melrose Ave., New York City.
2AX	500	Howard Blower, 664 E. 18th St., Brooklyn.
2AY	100	Burton Greenburg, 332 E. 67th St., New York City.
2AZ	500	Eugene S. Pearl, 307 Gregory Ave., Passaic, New Jersey.
2BA	550	H. M. Ash, Oakland, N. J.
2BB	990	I. R. Lounsberry, Jr., 15 Ann St., Ossining, New York.
2BC	50	Charles Mulligan, Washington Ave., Bergenfield, N. J.
2BD	24	Elmer G. Baier, 253 Ninth St., Brooklyn.
2BE	50	George S. Yerbury, 331 Lafayette Ave., Passaic, N. J.
2BF	500	B. H. Mills, U. S. Gen. Hospital No. 41, Fox Hills, S. I.
2BG	250	George F. Gaede, Pompton Rd., Paterson, N. J.
2BH	22	Henry G. Muller, 2900 Eighth Ave., New York City.
2BI	50	James Wood, 1420 Putnam Ave., Brooklyn.
2BJ	550	H. H. Dahms, 21 Manitou Ave., Poughkeepsie, N. Y.
2BK	700	Carl E. Trube, 6 Livingston Ave., Yonkers, N. Y.
2BL	25	Reed Cline, Main St., Millerton, N. Y.
2BM	770	E. Heermance, 523 State St., Hudson, New York.
2BN	800	E. G. Sisson, Jr., 57 Union St., Montclair, N. J.
2BO	500	M. A. McIntire, 1127 Ave. G, Brooklyn, N. Y.
2BP	500	John Pollock, 230 W. 99th St., New York City.
2BQ	236	Baldwin Guild, 636 Mt. Prospect Ave., Newark, N. J
2BR	75	Leroy S Callan, 1087 New York Ave., Brooklyn, N. Y.
2BS	500	Frdk. E. Garlick, 23 Occident Ave., Tompkinsville, N. Y.
2BT	12	Earl F. Adams, 1048 Julia St., Elizabeth, N. J.
2BU	50	Harold T. Sniffin, 730 E. 178th St., New York City.
2BV	12	Reginald K. Woodward, 84 Amherst St., East Orange, N. J.
2BW	500	E. T. Hynes, 2429 Valentine Ave., New York City.
2BX	18	Brownes Business College, Brooklyn, N. Y.
2BY	220	Erwin Oeller, 511 Mumford St., Schenectady, N. Y.
2BZ	250	Will T. Weatherbee, 609 W. 186th St., New York City.
2CA	50	Harry G. Lichtenstein, 1245 Madison Ave., New York City.
2CB	30	John D. Schram, 283 E. 32nd St., Brooklyn.
2CC	500	Clarence Collignon, Montvale, New Jersey.
2CD	980	Roger D. Prosser, Chestnut St., Englewood, N. J.
2CE	1000	J. W. Dain, 1100 Orchard St., Peekskill, New York.
2CF	75	Arthur E. Prince, 30 South Eldert Ave., Rockaway Beach.
2CG	550	Frederic K. Shield, Coxsackie, N. Y.
2CH	500	S. Isaacson, 900 Riverside Drive, N. Y. C.
2CI	25	Clarence H. Osborn, 97 Watkins Ave., Middletown, N. Y.
2CJ	500	Walter E. Bathgate, 102 High St., Passaic, N. J.
2CK	880	T. F. O'Brien, 19 Nassau Ave., Freeport, N. Y.
2CL	500	George L Storm, 742 Highland Ave., Newark, N. J.
2CM	220	H. Zimmerman, Jr., 2590 Third Ave., New York City.
2CN	220	Edward T. Dickey, 1649 Amsterdam Ave., New York City.
2CO	50	Peter Cooper, 512 Sewal Ave., Asbury Park, N. J.
2CP	600	Jas. P. Devine, 1068 University Ave., New York City.
2CQ	660	E. M. Washburn, 111 Miln St, Cranford, N. J.
2CR	75	Morris Lieberman, 524 Barbey St., Brooklyn.
2CS	1000	Charles M. Schaefer, 201 Park Ave., Port Richmond, N. Y
2CT	750	Matthias Thury, 878 Macy Place, New York.
2CU	24	H. B. Von Thun, 271 Decatur St., Brooklyn.
2CV	50	Herbert G. Rowley, 107 Clifton Ave., Newark, N. J.
2CW	995	F. M. Ham, 403 Prospect St., Westfield, New Jersey.
2CX	50	Ernest K. Seyd, 531 Washington Ave., Brooklyn.
2CY	50	Herbert G. Rowley, 107 Clifton Ave., Newark, N. J.
2CZ	440	Frank V. Becker, 12 Callister St., New York City.
2DA	1000	A. H. Winn, 325 Church St., Poughkeepsie, New York.
2DB	220	R. D. Zucker, 46 Clinton Place, Mt. Vernon, N. Y.
2DC	25	John Stofan, 95 Grand St, Garfield, New Jersey.
2DE	25	Arthur Mahn, 539 E. 145th St., New York City.
2DF	500	Harry G. Silversdorff, 641 Pavonia Ave., Jersey City, N. J.
2DG	108	Harry Y. Higgs, 30 Irving Place, Brooklyn, N. Y.
2DH	72	Samuel W. Knapp, 75 Cooper St., Brooklyn.
2DI	250	Ernest A. Cyriax, 219 E. 71st St., New York.
2DJ	1000	E. B. Lant, Scarsdale, N. Y.
2DK	50	Wm. R. Chinn, 25 Westchester Ave, White Plains, N. Y.
2DL	990	V. F Bangert, 34 Orchard St, Jamaica, N. Y.
2DM	880	H. C. Nightingale, 349 18th Ave., Paterson, N. J.
2DN	25	Arnold Brilhart, 10 Cornell Ave., Yonkers, N. Y.
2DO	30	Louis J. Wadsworth, 1494 Bushwick Ave., Brooklyn.
2DP	500	Charles Fucci, 606 Henderson St., Jersey City, N. J.
2DQ	12	R. W. Porter, 166 78th St., New York City.
2DR	500	T. C. Cooper, 269 Garfield Ave., Jersey City, N. J.
2DS	880	LeRoy Clark, Chestnut St., Englewood, N. J.
2DT	500	F. T. Hermann, 131 Main St., Hempstead, L. I.
2DU	100	J. E. Engstrom, 100 St. Marks Place, Brooklyn.
2DV	500	E. D. Hallett, 86 Prospect Pl., Rutherford, N. J.
2DW	18	J. J. Hallahan, 180 Market St., Perth Amboy, N. J.
2DX	100	I. R. Greves, 34 Hobart Ave., Summit, N. J.
2DY	500	A. J. Haynes, 128 W. 80th St., New York City.
2DZ	50	Daniel D. Hancock, Newman Springs Ave., Red Bank, N. J.
2EA	500	Edwin S. Crane, 47 Sinclair Ave., Flushing, N. Y.
2EB	50	Edward V. Neuser, Ridge St., Pearl River, N. Y.
2EC	24	F. C. W. Thiede, 486 Decatur St., Brooklyn.
2ED	400	Graham V. Lowe, 262 W. 77th St., New York City.
2EE	250	E. W. Maurer, 65 Osborn St., Keyport, New Jersey.
2EF	50	Theo. Hurd, 7 Tilton Ave., Red Bank, New Jersey.
2EG	1000	Egmont Arany, 62 W. 124th St., New York.
2EH	1000	E. M. Williams, 1627 Seventh Ave., Troy, New York.
2EI	500	Henry C. Quick, 471-75th St., Brooklyn.
2EJ	200	Russel Davis, 601 Page Ave., Allenhurst, N. J.
2EK	50	M. Ferris Roberts, 17 Heights Terrace, Ridgewood, N. J.
2EL	990	H. H. Carman, 217 Bedell St., Freeport, L. I., N. Y.
2EM	50	Chas. F. Jacobs, 279 Park Place, Brooklyn.
2EN	18	George B. Huss, 30 Clifton Ave., Lakewood, N. J.
2EO	50	Samuel Levelle, 255 So. Manning Blvd., Albany, N. Y.
2EP	25	Chas. P. Baulser, No. Main St., Pearl River, N. Y.
2EQ	990	J. J. Nightingale, 741 Market St., Paterson, N. J.
2ES	50	Frank M. Ende, MacFarland Ave., Arrochar Park, S. I.
2ET	500	G. B. England, 917 St. Nicholas Ave., N. Y. C.
2EU	50	Harry Davis, 520 Clinton Ave., Newark, N. J.
2EV	500	Edwin Lentz, 5 Mertz Ave., Hillside, N. J.
2EF	500	John C. H. Steinkamp, 89 Hyatt Ave., Yonkers, N. Y.
2EX	550	B. B. Jackson, 34 E. Newell Ave., Rutherford, N. J.
2EY	475	F. J. McKinney, 300 Glenwood Ave., Bloomfield, N. J.
2EZ	50	Jas McAnley, 311 W. 54th St., New York City.
2FA	24	Wm A. LeMay, 1117 Hutton St., Troy, N. Y.
2FB	24	Harold Cohn, 546 W. 146th St., N. Y.
2FC	50	Fred Clayton, 607 Emory St., Asbury Pk., N. J.
2FD	30	John DiBlaisi, 227 E. 75th St., New York City.
2FE	1000	M. G. Pawley, Blair Academy, Blairstown, N. J.
2FF	90	Harold S. Brower, 19 So. Clinton St., Poughkeepsie, N. Y.
2FG	1000	F. H. Myers, 540 Providence St., Albany, N. Y.
2FI	750	Geo. E. Cole, 36 Watsessing Ave., Bloomfield, N. J.
2FJ	50	Frdk. A. Girard, Magnolia St., Montvale, N. J.
2FK	440	Richard W. Freure, 439a McDonough St., Brooklyn, N. Y.
2FL	1000	K. R. Woodruff, 616 Clifton Ave., Clifton, N. J.
2FM	880	Francis McCartin, Jr., 524 Paige St., Schenectady, N. Y.
2FO	50	W. S. Blanchard, 401 Westervelt Ave., New Brighton, N. Y.
2FP	60	Harold Peiler, 321 E. 90th St., New York City.
2FQ	50	Joseph Pignone, 2065 Anthony Ave., New York City.
2FR	75	J. R. Richardson, 16 Culver St., Yonkers, N. Y.
2FS	500	Howard L. Stanley, Prospect St., Babylon, N. Y.
2FT	1000	Wm. E. Murray, 521 N. James St., Peekskill, N. Y.
2FU	180	Chas. I. Hertz, 510 W. 144th St., New York City.
2FW	990	C. V. Macpherson, 590 W. 172nd St., New York City.
2FX	880	Ray V. D. Gedney, Center Ave., Little Falls, N. J.
2FY	500	Dan Voepel, Jr., 1140 Clay Ave., New York City.
2FZ	500	F. Frimerman, 334 E. 100th St., New York City.
2GA	32	F. W. Miller, 4 Hicks Ave., Winfield, L. I.
2GB	50	Frank H. Giefer, Ravenhurst, West New Brighton, N. Y.
2GC	50	A. E. Sonn, 282 Parker St., Newark, N. J.
2GD	750	R. G. Kaufman, 20 Llewellyn Ave., Bloomfield, N. J.
2GE	990	George C. Otten, 58 Chichester Ave., Jamaica, N. Y.
2GF	48	J. C. Ruckelshaus, 566 Ridge St., Newark, N. J.
2GG	9	Chas. P. E. Gruetzke, Jr., 1237 Brook Ave., New York City.
2GH	500	M. Hardy, 373 W. 126th St., New York City.
2GI	50	Henry J. McCue, 76th St. and Shore Road, Brooklyn.
2GJ	440	E. G. Cronenmeyer, 1269 Theriot St., New York City.
2GM	50	W. Grumbacker, 514 W. 170th St., New York City.
2GN	50	John H. Peitler, 45 53rd St., Corona, N. Y.
2GO	50	H. G. Mulligan, 356 Madison Ave., Albany, N. Y.
2GP	50	Thos. Martin, 15 Troy Road, Menondo, N. Y.
2GQ	18	Chas. T. Manning, 81 Maple Ave., East Orange, N. J.
2GR	1000	John M. High, Jr., 254th St. and Independence Ave., N. Y.
2GS	75	Geo. D. Stewart, 90 N. Bway, Yonkers, N. Y.
2GT	600	J. V. N. Bergen, Port Jefferson, L. I.
2GU	36	N. Y. Catholic Protectory, Walker Ave., Van Nest, N. Y.
2GV	550	C. J. Ripperger, 147 Wisner Ave., Middletown, N. Y.
2GW	440	C. L. Homan, Sayville, L. I., N. Y.
2GX	500	Y. M. H. A., 92nd St. and Lexington Ave., N. Y. C.
2GY	50	Frank X. Hayes, 162 E. 82nd St., New York City.
2GZ	220	Robt. C. Barnes, 916 E. 179th St., New York City.
2HA	275	W. H. Sands, 80 Forster Ave., Mt. Vernon, N. Y.
2HB	22	H. L. Brown, 152 S. Broadway, Yonkers, N. Y.
2HC	250	Gordon Peck, 68 Woodruff Ave., Brooklyn.
2HD	12	K. C. Underwood, 54 N. 11th St., Newark, N. J.
2HE	50	Leroy Wm. Rock, 201 Beach St., Red Bank, N. J.
2HF	250	Chas. W. Coote, 725 W. 172nd St., New York City.
2HG	500	G. W. Krueger, 73 Lincoln Park, Newark, N. J.
2HH	500	P. H. Betts, 238 Valley Road, Montclair, N. J.
2HI	80	Howard I. Becker, 185 Division St., Schenectady, N. Y.
2HJ	15	H. J. Hasbrouck, Jr., 71 Elmont Ave., Port Chester, N. Y.
2HK	500	H. Geitz, 1926 Bleecker St., Ridgewood, L. I., N. Y.
2HL	25	M. Freyfus, 154 Fairmount Ave., Newark, N. J.
2HM	50	Clarence A. McKee, 821 E. 216th St., New York City.
2HN	440	Chas. H. Burch, 72 Third St., Long Island City, N. Y.
2HO	850	Wm. B. Lyons, Broad St., Bloomfield, N. J.
2HP	50	Thos. Martin, 15 Troy Road, Menondo, N. Y.
2HQ	50	Frdk. Doscher, 246 Morris Ave., Rockville Centre, N. Y.
2HS	25	Donald Van Brakle, 83 Maple Pl., Keyport, N. J.
2HT	50	Howard W. Ticknor, 316 Mt. Prospect Ave., Newark, N. J.
2HU	472	Grosvenor Hotchkiss, 146 Halsey St., Brooklyn.
2HV	50	Edw. D. Blodgett, 335 Rugby Road, Brooklyn.
2HW	16	Frank M. Hanna, 1211 Hutton St., Troy, N. Y.
2HX	100	Harry Alexander, 838 Riverside Drive, New York.
2HY	1000	Nelson M. Smith, 143 Norton Ave., Port Chester, N. Y.
2HZ	585	Arthur F. Clough, 96 Hamilton Ave., Yonkers, N. Y.
2IA	500	F. V. Bremer, 3613 Boulevard, Jersey City, N. J.
2IB	25	T. V. Geohegan, Pleasant Ave., Athenia, N. J.
2IC	990	Raymond I Gratzner, City College of N. Y., New York.
2ID	50	Frank H. Schubert, Thatcher Ave., Harrison, N. Y.
2IE	24	H. A. Benzing, 802 E. Jersey St., Elizabeth, N. J.
2IF	500	John H. Bates, 513 Tinton Ave., New York City.
2IG	36	Wm. K. Caughey, 25 Mada Ave., W. New Brighton, N. Y.
2IH	25	Leo Samuels, 43 Treacy Ave., Newark, New Jersey.
2II	30	W. J. Howell, 135 Edgecombe Ave., New York City.
2IJ	50	Wm. Weller, 2156 Webster Ave., New York City.
2IK	550	O. L. Davis, 1337 S. Boulevard, New York City.
2IL	250	G. C. McClintock, 319 Dudley Ave., Westfield, N. J.
2IM	11	E. C. Williams, Jr., 120 Greenway North, Forest Hills, N. Y.
2IN	750	Geo. T. Droste, 203 E. 202nd St., New York City.

(To be Continued.)

A Small Radiophone Transmitter

By Clinton R. White

LITTLE has been said about radiophone transmitters in the past, yet many amateurs would have a wireless telephone transmitter were it not for the very high cost of the sets made up by dealers. This article is intended to make clear just what is necessary, and how to construct a complete short distance wireless telephone transmitter at a small cost.

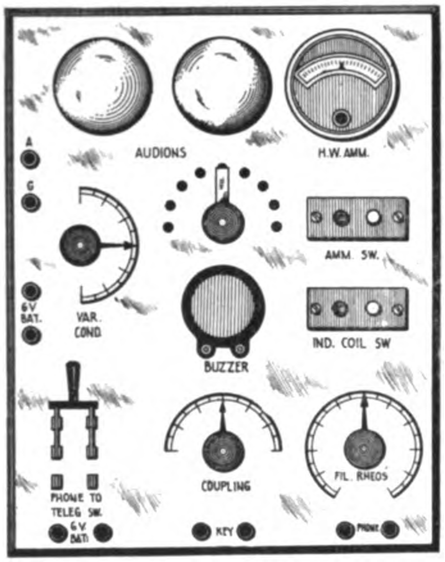


Figure 1

Figure 1—Front view of the panel showing position of instruments

First, a list of the material necessary: 2 Marconi VT transmitting tubes; 2 sockets; a hot wire ammeter (0 to 1 ampere); a telephone transmitter; a filament rheostat; a 43-plate variable condenser; a telephone induction coil; a double-pole-double-throw knife switch; 2 single-pole-single-throw switches; a wireless key; 10 binding posts (small size); a piece of good insulating material, such as bakelite, rubber, or even wood, size about 12 x 14", ⅜" thick; a fuse block with two 3-ampere fuses; a half-pound of No. 20 D.C.C. magnet wire; a bakelite or cardboard tube, 4" in diameter and 3" high, another 3" in diameter and 2" high; and a good high-pitch buzzer.

Many amateurs will have some of the listed apparatus around the work shop. The average amateur knows how to mount the various instruments on the rear of panel, as this subject has been gone over many times in previous articles in THE WIRELESS AGE. By studying the diagram, one can readily see how the instruments are placed.

The small vario-coupler can be made and mounted in the following manner:

Wind 40 turns of the magnet wire on the larger tube, taking taps off at every 10 turns. Then wind 30 turns on the small tube, taking taps off at each end and one long flexible lead from the center. Mount the large coil on the back of panel, as shown in diagram, then mount small coin as shown. After the large coil is mounted, solder leads from the large coil to ten taps.

If house current is used, it is very important that the positive side of the lighting circuit be found. This can be determined by a glass of water with a little salt in it; when the ends of the wires are dipped in the water the negative will bubble.

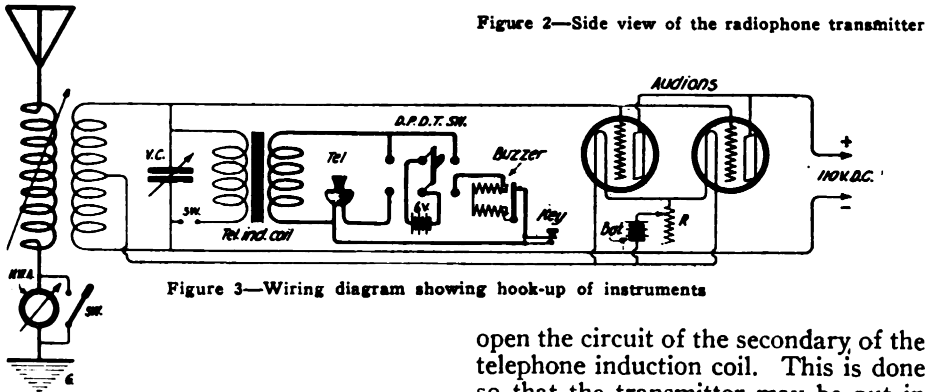


Figure 3—Wiring diagram showing hook-up of instruments

Additional bulbs may be connected in parallel, which will add to the output. The variable condenser serves to tune the closed circuit while the tapped large coil varies the open circuit. It will be noted that there is a switch to open the circuit of the secondary of the telephone induction coil. This is done so that the transmitter may be put in series with the ground lead for experiment leaving the closed circuit free.

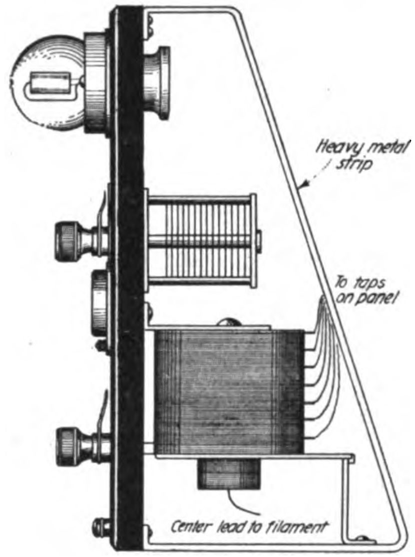


Figure 2

Figure 2—Side view of the radiophone transmitter

Design and Construction of a Short-Range Wavemeter

By A. Rosander

A VERY essential but seldom used piece of apparatus in amateur stations is a wavemeter. A wavemeter consists of, in essence, a calibrated receiving circuit, by means of which transmitter circuits are tuned to a desired wavelength. In an ordinary wavemeter—the one described—the inductance of the exploring coil is fixed with the variable condenser calibrated so that each degree setting will correspond to a given wavelength. The wavelengths due to these changes in capacity are usually shown by a graph curve accompanying the wavemeter. This can be explained from the fundamental fact that every circuit containing fixed inductance and capacity has a distinct wavelength at which it will oscillate more freely than all others. By varying the capacity a complete set of waves (wavelengths) can be obtained for a given fixed inductance and variable condenser.

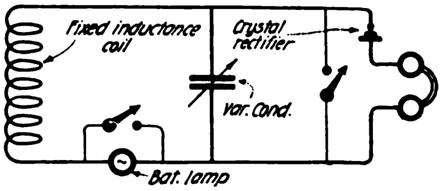


Figure 1—Circuit diagram of the short-range wavemeter

This wavemeter is inexpensive and accurate enough to comply with the law. It is similar to the low range wavemeter described on page 46 in "How to Conduct a Radio Club." It consists of the following pieces of apparatus: a fixed inductance; a variable condenser; crystal detector or lamp, or both; and an ordinary 2000-ohm head set. The inductance consists of 22 turns of No. 16 S.C.C. copper wire wound on a shellacked cardboard tube 6½ inches in diameter. This tube is mounted on standards somewhat like primaries of receiving transformers. Flexible connections, one foot long are made from each end of the coil to the variable condenser. The variable condenser is an ordinary Murdock variable condenser having a maximum capacity of .0005 mfd.

The detector and condenser are mounted on a base with room for holding the inductance coil when it is not in use. These pieces of apparatus are so fixed that they can be incorporated into the ordinary receiving set without any inconvenience, thus reducing the cost to a minimum and comprising a very compact wavemeter. In preference to using a crystal detector and phones for tuning the primary circuit, a small 2 or 4-volt battery lamp may be used, provided it has a proper short-circuiting switch.

In conjunction with this, using a current indicator such as a milli-ammeter or hot wire wattmeter, a resonant curve may be plotted from which an accurate idea of the purity and sharpness of the emitted wave may be obtained. Nothing is of more importance than knowing these two conditions. The manipulator will then know whether or not he is complying with the law, and furthermore, can quickly ascertain whether the radiated energy appears in a single sharp wave or in two or more broad waves.

With this necessary adjunct and a hot wire ammeter in every station, the efficiency of amateur stations will rise to an unprecedented height.

WAVEMETER DATA

Degrees of Condenser Scale	Corresponding Values of Wavelength
0	140
10	160
20	195
30	235
30	260
40	300
60	300
80	340
100	365
120	400
140	440
160	470
180	500

Indoor Antenna

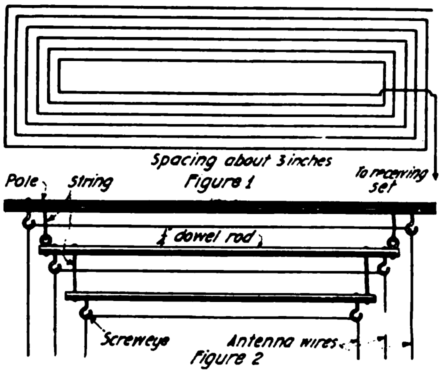
By C. Chandler Pidgeon

THE article in THE WIRELESS AGE for March, 1920, beginning near the bottom of page 40, entitled "Apartment House Antenna," attracted my attention. Since I live in an apartment house, I have had to solve the same problem, and I submit the following for your consideration.

Being desirous of operating a receiving set, and being unable to have a regular aerial, I tried several things, principally the bed springs, the gas fixtures, and a loop, such as is used in direction finders. None of these proved very satisfactory.

One evening I measured the length of the small hallway in our apartment. This I found to be nearly 30 feet. By placing bamboo poles across between the tops of door frames at opposite ends of the hall, I had a space 3 feet wide and 25 feet long for my antenna. In that space I have hung eleven turns of wire, arranged as in figure 1. I suppose any wire would do, but I happened to have No. 22 cotton covered enameled wire and used that.

With this antenna and a 200 to 3000 meter receiving set, I receive the time signals from Arlington and hear some of the radio telegraph and telephone work that is being carried on at about 200 meters in the city and surrounding neighborhoods.



Figures 1, 2—Constructional details of the indoor antenna

My receiver is very small and quite young yet, so I don't get much in the way of results. I am using a "crystaloi" detector now and am sure the results I get are as good as can be expected. The batteries for my audion set are out of order, but when working I could hear NAA 20 feet from the phones, using a single "audiotron" bulb. As soon as I get my two-step amplifier to work and with sufficient inductances, I hope to have all of the large stations on the Eastern coast and probably some European stations.

The antenna I use is one which any apartment dweller may put up with little expense and I feel sure the results will be better than those which can be attained by the scheme given on page 40 of the March WIRELESS AGE.

Figure 2 shows a detail of the manner of supporting the wires. I have too many turns for 200 meters, but I use a series condenser and have not bothered to take down a few turns of wire.

A Two Stage Amplifier Cabinet

By Arno A. Kluge

IN THE average amateur receiving set, no provision has been made for the use of a number of vacuum tubes such as are required for multi-stage amplifiers, but this difficulty may be overcome by the construction of an amplifier cabinet, and the original receiving equipment thus retained intact. A two stage amplifier will be found the most suitable for all-around amateur purposes, as the investment required for tubes, coupling transformers, and batteries will often be found prohibitive in the more elaborate equipment.

In figure 1 such a cabinet is shown. It consists of an oak or mahogany box about 12 inches square and 6 inches deep, having hard rubber or bakelite panel for the front. The top of the

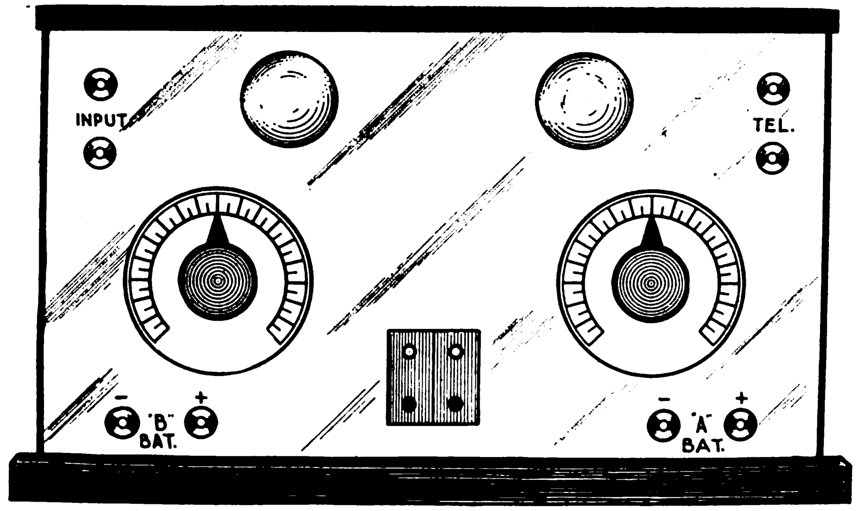


Figure 1—Front view of the amplifier cabinet

box is hinged, to give ready access to the vacuum tubes, which are mounted inside the box for greater protection. Two circular celluloid windows are provided for observance of the filaments during operation. Directly below these are two "back-mounted" rheostats for controlling filament current. In the center of the panel near the bottom are two miniature flush switches for turning the supply current on and off.

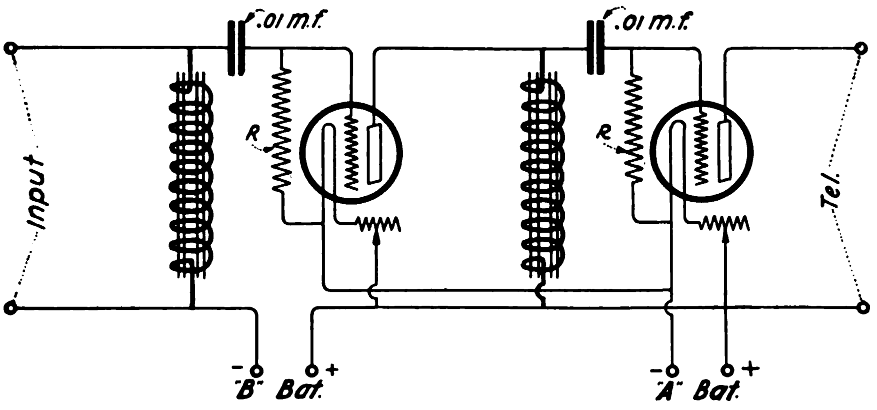


Figure 2—Circuit showing tubes coupled to each other and to the input circuit by use of impedances

Sockets for the tubes are fastened to the back of the box inside. Their type will depend upon the style of tube used. No design is shown therefore. In case that the tubular style with wire leads is used, binding posts will of course have to be provided.

The tubes are coupled to each other and to the input circuit either by the use of impedances, as in figure 2, or by the use of coupling transformers, as in figure 3. The circuits shown are used in Signal Corps receivers, type SCR-59 and SCR-72, and require only one "A" battery and one "B" battery. Other circuits, such as that furnished with the Marconi V. T. tube, may of course be used, depending largely upon the style of tube employed.

Of the two circuits shown above, the one employing coupling transformers is the simplest and the best, no grid condensers or grid leak resistances being required. In figure 2, the resistances R are 2 megohms each, and give the grid a slight negative potential. The impedances consist of 25,000 turns of No. 38 enameled wire, wound on an iron core 2 inches long and ½ inch in diameter. The completed coil will be about 1 inch in diameter, and should be enclosed in a soft iron case.

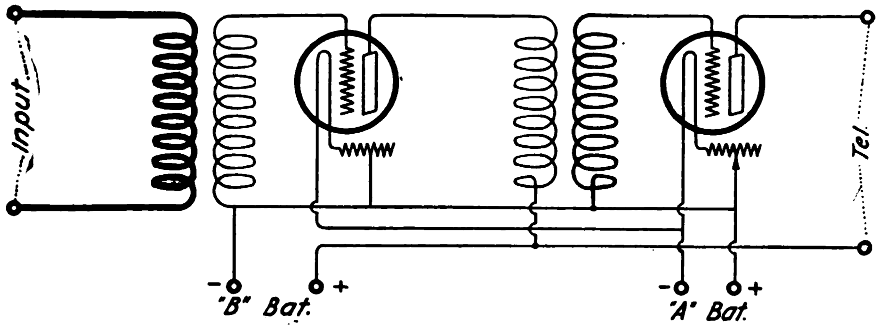


Figure 3—Circuit showing coupling secured by means of coupling transformers

For the circuit of figure 3, the coupling transformers should consist of 4,000 and 12,000 turns of No. 44 enameled wire on the primary and secondary respectively. Owing to difficulty attending the winding, these are best purchased complete.

The last mentioned is a closed core transformer. Core pieces may be cut from thin annealed iron to form an "L" 2½" high and 1½" broad, the body of the "L" being ½" wide. These are then built up after coil is wound and so placed that the coil is on one leg of a hollow rectangle formed by the "L" shaped pieces. A core of 8 inches long and ⅞ inch in diameter is used for the open core type, with 15,000 turns of No. 34 on the primary, and 25,000 turns of No. 38 on the secondary.

These dimensions should enable the amateur to construct a suitable amplifier for any style of bulb, and such an instrument will shortly find a place in every up-to-date station.

The Design and Construction of a Simple Wavemeter—Range 150 to 300 Meters

By F. C. Brockman

First Prize—$10.00

THIS wavemeter is designed so that the average amateur with few tools can make it. Some of the construction is intended to provide substitutes for parts which require the use of machine tools in their manufacture. I have made most of the apparatus with very few exceptions without the use of machine tools. Most amateurs have a large stock of odds and ends on hand which they will want to use and for them the design is intended as a guide.

The essentials of a wavemeter are, of course, an inductance and a capacity—that is, a coil and a condenser, in series. This circuit will oscillate at a wavelength determined by the relation between the inductance and the capacity according to the expression:

$$\lambda = 1884\sqrt{LC} \qquad (1)$$

where L is the inductance in microhenries and C the capacity in microfarads. The condenser selected for this instrument is made by the General Radio Company. By ordering their No. 124C, the condenser, handle, and scale can be obtained without the case, cover, or binding posts. The plates are made of hard aluminum and are rugged enough to withstand ordinary usage without bending. The ten rotary plates are cut away to give approximately geometric variation of capacity, allowing closer adjustment at the lower end of the scale. The support of the condenser itself is a ribbed aluminum casting to which is riveted a dilecto disc riveted in turn to an accurately machined brass bearing about 1 inch long. The shaft is accurately machined with a flange which locates the plates and acts as a thrust bearing. The contact for the rotary plates is made through a bronze spring washer. The brass scale rotates opposite a line indicator so that readings are always made at the same point. A knob is used for ordinary adjustments while an extension handle is very useful for fine adjustments. The minimum capacity is about 0.00002 mfd., the maximum is 0.00065 mfd. Curve A, figure 11, is the calibration curve of the condenser used.

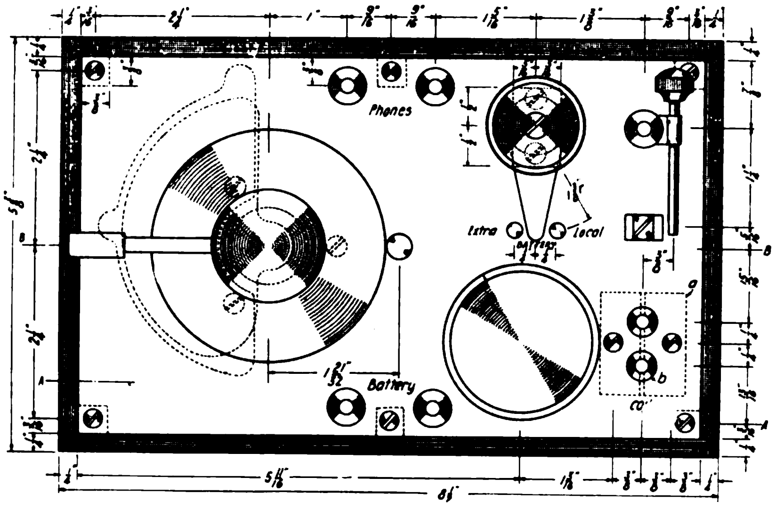


Figure 1—Top view of the wavemeter itself with constructional details

Figure 1 is a top view of the wavemeter itself. Figure 2 is a side view in sections. Figure 3 is an inside view of the cover. Sufficient dimensions are given for construction. The corners of the box and cover are lock-jointed and finished afterwards. This joint makes a strong box of neat appearance. The cover and bottom are glued and nailed or screwed on after the sides and ends have been glued together. Mahogany of the softer grades is easy to work and can be given a neat wax finish. A small suitcase handle can be fastened to the cover, or a strip of leather can be secured to it as desired.

The panel is preferably of 3/16 inch XX black dilecto, although hard rubber may be used. The dilecto can be given a neat grained finish by rubbing lengthwise with a piece of emery cloth fastened to a block of wood until all the high spots are taken off and the surface presents a uniform appearance. The panel is fastened to six supports by number 6-32 round head screws. The supports may be 3/8 inch square brass drilled as shown in the section at A, figure 2, or they may be of wood, glued in the corners of the box. In this case wood screws are used for securing the panel.

Mount the condenser as shown dotted in figure 1. The condenser is held on by three No. 6-32 flat head screws. The dial and knob are held to the shaft by a set screw under the end of the extension handle.

No drilling dimensions are given for the buzzer because they are easily determined from the base of the buzzer to be used. It may be either a "Century" high frequency buzzer, made by the Century Telephone Construction Company, or a Mesco No. 55 radio buzzer, advertised in various issues of this magazine.

The plug receptacle is made of two 3/8 inch brass bushings B, figures 1 and 5, forced into a dilecto block shown at A, figures 1 and 5, and pinned. It is best to make the block first, secure it to the front of the panel at the proper place and use it as a templet for drilling the panel holes. Be sure to drill carefully so that the dilecto will not splinter as the drill breaks through. Instead of dilecto, hard rubber or hard wood may be used, but in the latter case, it is held to the panel by No. 6 wood screws. The block serves as a reinforcement for the thin panel and makes a sturdy receptacle. The bushings are shown at B, figures 1 and 5, and are long enough to project 1/16 inch above the panel. If it is found inconvenient to use screws for securing the wiring to them, drill the 3/16 inch holes through and cut slots across the ends or drill holes just large enough to hold the wire used.

The battery switch is shown in section in figure 4. The blade is made from phosphor bronze or coe bronze 1/32 inch thick, although spring brass may be used. The width of the blade, as well as the length of the shaft (a No. 10-32 screw) depends on the style of knob used. The blade is held to the knob by a nut and washer. The bushing is a 3/8 inch diameter brass rod with a 3/16 inch hole through the center. The switch is secured to the panel in the same way in which the plug receptacle is secured, using the same precautions in drilling and allowing the bushing to project 1/16 inch. Connection is made to it by soldering a flexible lead to the nuts on the end of the shaft, or by soldering the wire into a hole in the side of the bushing. The switch points are made of 3/16 inch brass rod forced into the panel. The lower end of each has a saw slot into which the connections are to be soldered.

The detector is of the "cat-whisker" type and is shown in figure 1 and 2 with details in figures 6 and 7. Figure 7 shows the crystal clip which is made of 1/32 inch phosphor or coe bronze held to the panel by an 8-32 round head screw. Figure 6 shows the arm holder made of the same material. The arm itself is 1⅞ inch long by ⅛ inch diameter, threaded 6-32 on one end and fitted with a wire cat-whisker on the other. It is clamped in the holder by tightening the nut on the binding post. The knob may be of any convenient shape, a simple one being like that on the condenser arm.

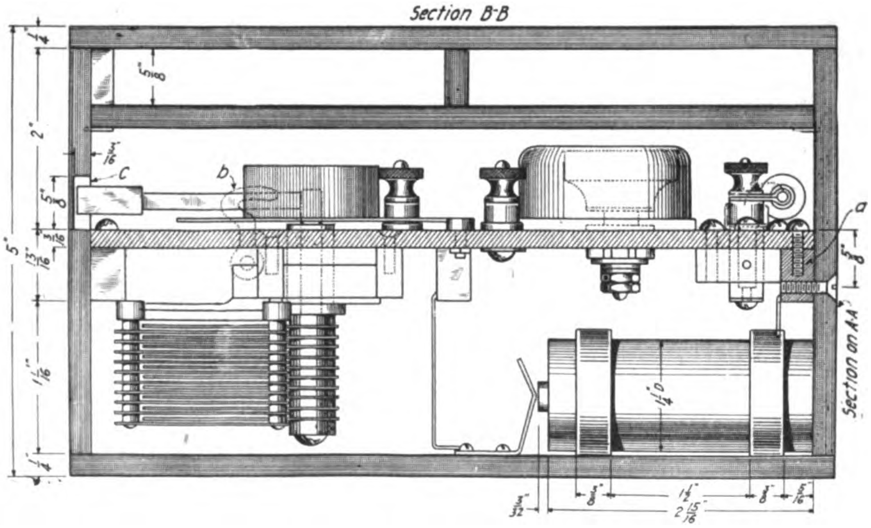


Figure 2—Side view in sections

Two pairs of binding posts are provided, one for the phones, the other for an external battery.

Figure 2 shows a battery mounted in clips in the bottom of the box. The battery shown is an Eveready as made for the U. S. Signal Corps. However, any small flashlight battery is suitable and for that reason the dimensions of the clips are not given. A convenient way for wiring it is to solder leads to the proper clips and to two of the panel supports, if they are of metal. Connection is taken from them by leaf copper held between the panel and the supports and clamped by the panel screws.

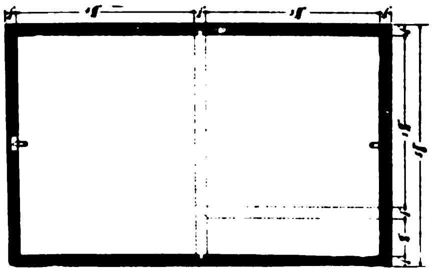
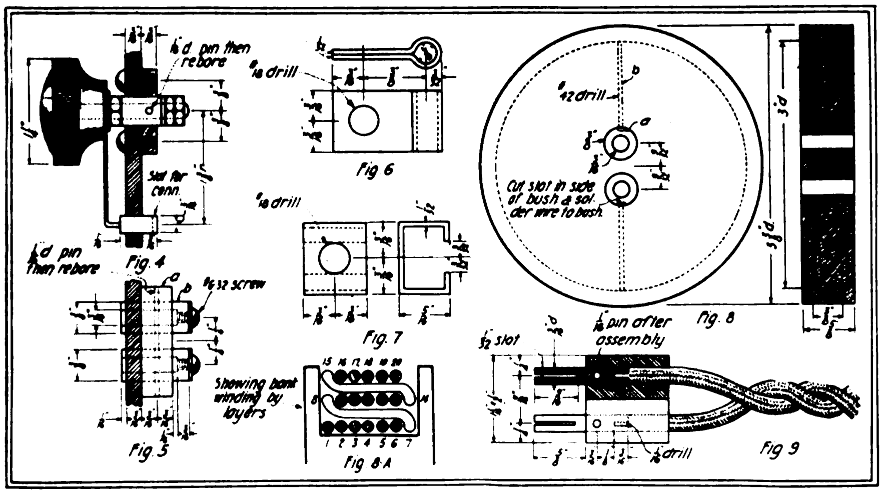


Figure 3—Inside view of cover with constructional details

Figures 2 and 3 show the inside of the cover. It provides a place for the coil, the cord, and crystals. There is no place for telephones, as they are generally in the receiving circuit and never packed away. If desired, the internal battery may be eliminated and a compartment with a door in the end of the box made for the phones. The calibration curve may be pasted to either side of the lid inside the cover. The cover is held to the box by four hooks shown dotted at B, in figure 2. The slot in the edge of the cover shown at C, figure 2, and A, figure 3, fits over the condenser handle and keeps it from swinging when carrying the meter.

The inductance used is shown in figure 8. The spool used by the writer was turned from ⅝ inch XX black dilecto sheet. The amateur who has no lathe may make his spool of the ⅛ inch mahogany used in cigar boxes. To do this, but three discs 3 inches in diameter and two discs 3⅜ inches in diameter are needed. Glue them all together to form a spool with a hub ⅜ inch long by 3 inches in diameter as in figure 8. Clamp while gluing and when dry reinforce with three ¼ inch wood dowels forced and glued in. Finish neatly when dry and apply two coats of Ajax or Sterling varnish. These are the best to use. Shellac may be used if the others cannot be obtained, but the spool must be thoroughly dried before and after applying it. Drill two ⅜ inch holes for the brass bushings, which also serve as coil terminals. The bushings are made of ⅜ inch brass rod and have a saw slot on one side as at A, figure 8. Tin the slots before assembling the bushings so that a good electrical connection can be made.



Figures 4, 5, 6, 7, 8, 8A, 9—Details giving constructional dimensions

For the coil, wind 20½ turns of No. 20 DCC copper wire, banked by layers (figure 8a). Push the ends through the lead holes, B, and let about ⅜ inch project into the ⅜ inch holes. Tin the ends of the wires. Force the brass bushings into the holes in the spool, being careful to get them tight and see that the coil ends fall in the slots. Apply heat to the bushings, also a little solder to secure a good connection. Treat the winding with varnish and cover with book binder's cloth to give a neat appearance.

The plug connection is shown in figure 9. The block is preferably made of hard rubber as dilecto or wood splits if the plugs fit very tight. However, with reasonable care, dilecto may be used and makes a better finish. In order to secure good alignment it is best to use the receptacle in the panel on a templet for one and that in the coil as a templet for the other when drilling the 3/16 inch holes through the blocks. The plugs are of 3/16 inch brass rod—though coe bronze has more spring—worked down with emery cloth till they fit the receptacle bushings snugly without forcing. Then slot one end of each and drill a small hole about 3/16 inch deep in the other end.

For the cord use 20 inch of No. 16 or 18 twisted lamp cord with extra heavy insulation. This is not for protection against high voltage, but for obtaining greater spacing of the wires and hence lower capacity in the cord itself. A better way is to take two individual wires and make a flat cable by sewing them with their centers 9/16 inch apart to a flat strip of leather or heavy canvas doubled around them. The capacity of this length of lamp cord having thin insulation, is about 0.000039 mfd., which is the capacity of the condenser at about 16.8 divisions. A high capacity cord will raise the minimum wavelength considerably more than the maximum, thus reducing the ratio of maximum to minimum, or the range of the instrument.

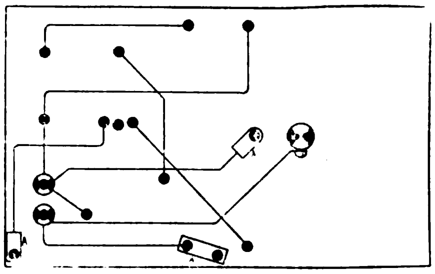


Figure 10—Wiring diagram under the panel

Thread the wires through the holes in the blocks and solder the ends into the holes in the plugs. Draw the wires back through the blocks and force the plugs in after them. Drill two small holes and pin the plugs as indicated in the figure.

Figure 10 shows the wiring under the panel. It should be made with No. 16 bare solid wire, though other sizes not smaller than No. 20 will do. Where wires cross, bend the outer one to clear that next to the panel to prevent short circuits. All joints should be securely soldered. Connection is made to the condenser stationary plates as well as to the panel supports carrying the internal battery

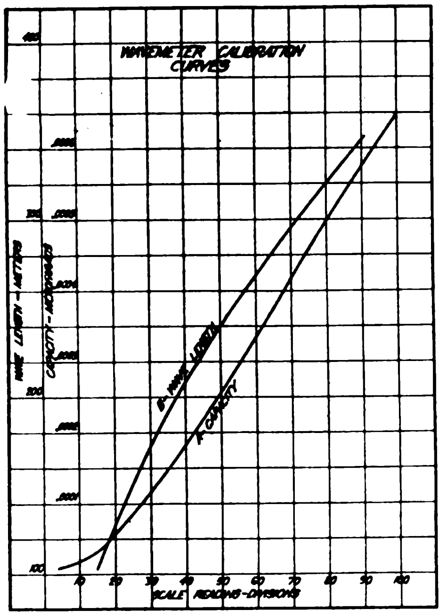


Figure 11—Graphs showing the capacity and wavelength calibration of the meter

connections by strips of leaf copper as shown in figure 10.

Figure 11 shows the capacity and wavelength calibration of the meter, and table I gives the values for replotting them if desired.

The instrument can be used as a receiver for measuring the wavelength of a transmitter, or as a transmitter for measuring the wavelength of a receiver or other circuit. Coupling it in the antenna circuit of a receiver, tuning in a signal on the receiver, and then tuning the wavemeter till the signal in the receiver phones is a minimum will give the wavelength of the received signal. Another method is to tune in a signal and then operate the wavemeter as a transmitter in proximity to the receiver secondary circuit and tuning it till the two are in resonance. The wavemeter then shows the wavelength of the received signal. Coupling between the two must be fairly loose so that coupling waves are not generated, as these waves are of different frequencies from the desired wave.

The wavemeter may also be used to measure inductance or capacity, when one or the other is known, by the use of formula (1).

TABLE I

Condenser Divisions	Wavelength	Capacity
10	...	.000018
15	102	.000033
20	126	.000055
30	171	.000116
40	207	.000183
50	239	.000257
60	268	.000335
70	296	.000417
80	321	.000498
90	344	.000576
100	...	.000650

Simple Wavemeter

By O. E. Cote

Second Prize—$5.00

HEREWITH are the drawings and photos of a simple wavemeter. This meter, while being simple, is at the same time very rugged and of reliable construction throughout. Complete drawings will be omitted, as the average experimenter can suit himself as to the design of the containing case as well as detector and buzzer switch. Figure 1 shows the general layout of the panel, which is made of bakelite and finished in the usual way.

Figure 2 shows the construction of the buzzer and although many amateurs will undoubtedly use other types of ready-made buzzer, this construction will be of some help to many.

Part No. 1 is the yoke and is made of soft iron. Part No. 2 can be either brass or fibre, as this only serves the purpose of holding the yoke away from the panel. Part 3 is a brass bushing and holds the adjusting screw 4, which is also made of brass. Part 5 is a small brass washer which fits under spring 6. This spring is for the purpose of keeping a tension on the adjusting screw. 7 are the magnet cores, which are made of soft iron. After the magnet coils are assembled on these cores, the latter are driven lightly into part 1.

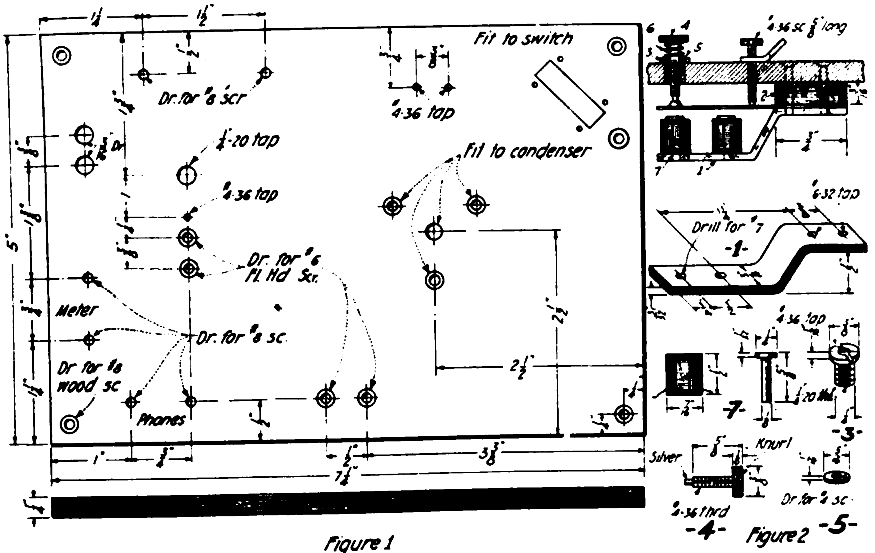


Figure 1

Figure 2

Figures 1, 2—General layout of the panel and construction of the buzzer

The magnets each contain about 420 turns of No. 32 enameled wire. I have used a piece of silicon steel about .01 inch thick for the vibrator and it gives very good results.

Figure 3 shows the holder for the battery. No dimensions are given, as the maker can use his own judgment, but it will be found that a flashlight battery (round) will do very nicely.

The coils and clips are shown in figure 3. The holders are of brass with a piece of bakelite in between, which holds the small bushing into which the connecting plug fits. The coils are made in the following manner.

Coil No. 1, which is the small one, contains 20 turns of 48/38 double silk covered litzendraht.

A tube is made by wrapping around an arbor 2¾ inch diameter about 5 or 6 wraps of brown wrapping paper having glue on one side in order to hold the tube together after it is removed from arbor. This tube is 9/16 inch wide, and takes just ten turns of wire for one layer. Two layers are put on and leads soldered to brass pieces as shown in sketch figure 3. Several thicknesses of paper or var-

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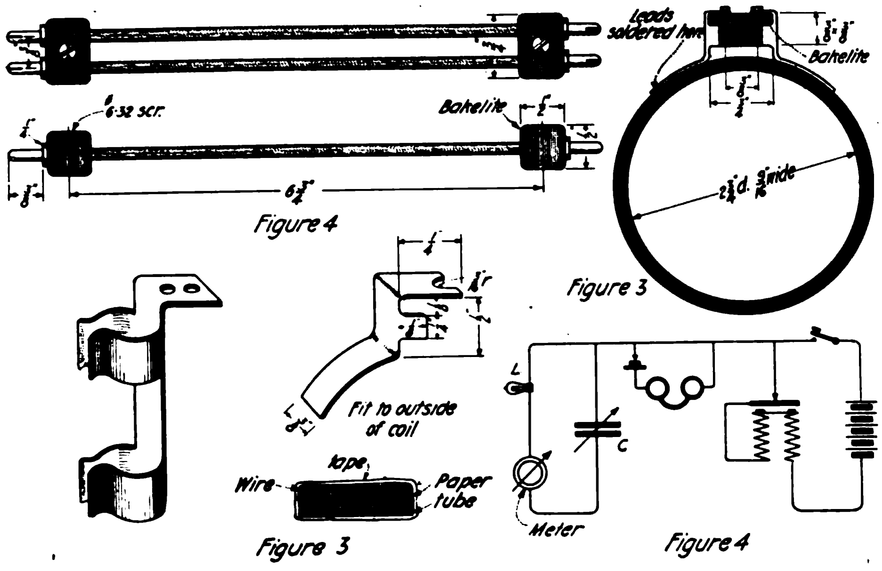
nished linen must be put between these holders and winding for insulation. After this, the coil is taped with ordinary cotton tape ⅜ in. or ½ inch wide. The taping is carried over the ends of the holders which fasten to the cord. The bakelite end pieces are split and by bringing them together with the flat head screws they hold the brass plugs securely in place.

The condenser used is the General Radio type 182C. This condenser is



Figures 3, 4—Coils, clips, connectors and hook-up

coil. The outside of the coil is then shellacked. The second or large coil is made in the same manner and contains 70 turns. One thickness of ordinary manila paper is put between each layer of wire to cut down distributed very rugged and is ideal for this type of instrument. A chart is also enclosed giving the wavelengths and if the amateur would prefer, he can make it direct reading by fastening a piece of white paper on the dial and

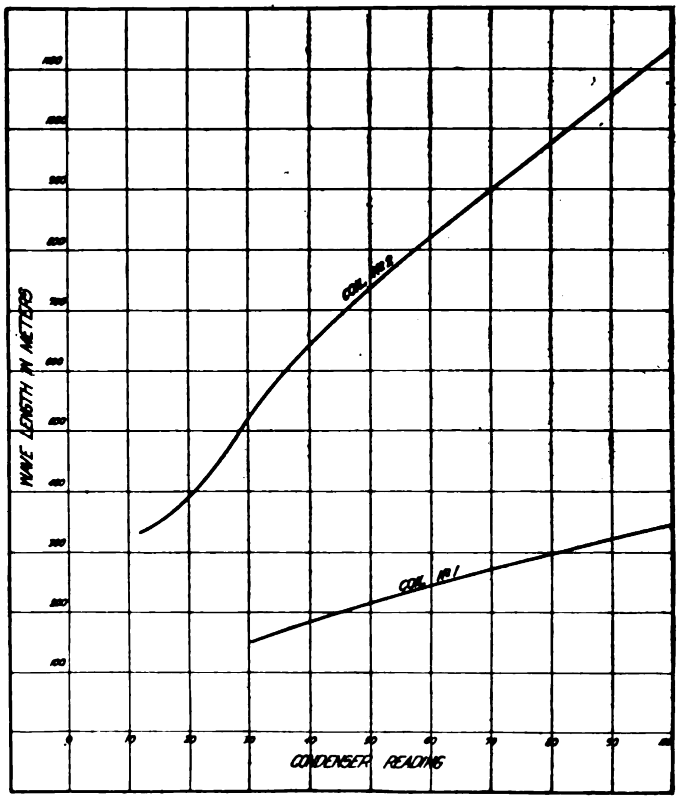


Figure 5—Graphic chart showing calibration of meter

capacity. The inside diameter of the big coil is 2¼ inches.

Figure 4 shows the connectors. The wires are rubber covered silk lamp marking down the wavelength direct. I would advise the maker to calibrate his meter from some other standard, as it will be found that the condenser

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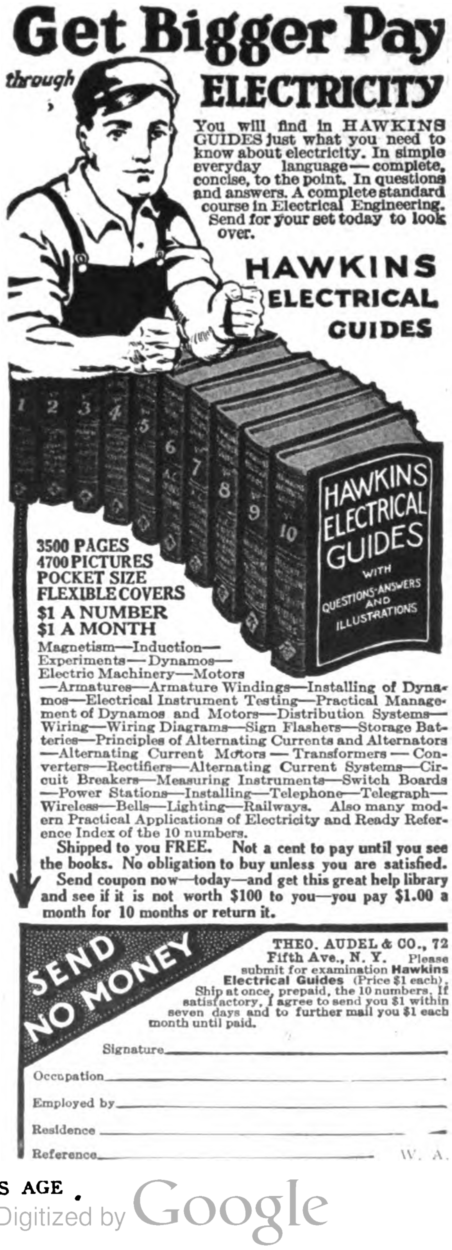
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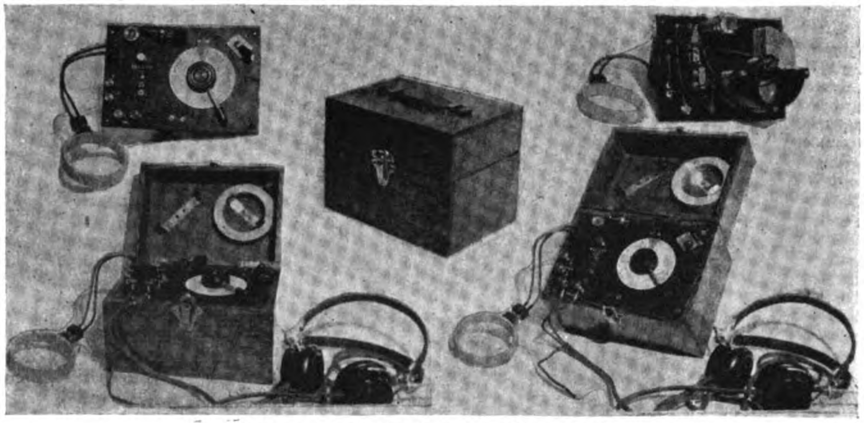

Photos giving various views of the meter

values vary slightly and it is also very hard to duplicate a set of coils unless they are all made at one time. Two binding posts are brought out and marked "meter" so as to be able to connect a milliammeter for quantitative measurements. These binding posts are short circuited when no meter is used in order to complete the circuit through the coil.

A Wavemeter for $3.50

The Design and Construction of a Simple Wavemeter

By E. S. Herrick

Third Prize—$3.00

The wavemeter described in this article was built to fill a long felt want. It not only has proven itself satisfactory in every way in my own station, but it has been used by several friends in the vicinity, who do not possess such an instrument.

The meter was personally calibrated to a U. S. standard wavemeter at a Government radio laboratory. The condenser was also calibrated to a standard condenser. Both curves are given (figure 1), and with these, one may determine the inductance of most any circuit from the formula $\lambda = 1884\sqrt{LC}$.

It is, of course, known that another condenser may not have exactly the same capacity as the one here described, neither may two inductances built to measure, have identical values in microhenries. However, the curves and values of this instrument and another built as near as possible to these specifications, will not differ to such a degree as to make an appreciable difference.

My own little meter has paid for itself many times over. It has been put to many uses, such as tuning the transmitter, calibrating my receivers, measuring inductances, and last, but not least, it has been used as a secondary of a loose coupler. It makes

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an excellent secondary receiving circuit and if slid along the table, to and from a primary coil, any degree of coupling may be obtained.

The condenser used is a Murdock 17-plate variable air condenser. This makes a light, durable, little unit and costs but two or three dollars. The inductance is wound on a tube, figure 2, 2½ inches outside diameter and 1 inch in width. Two holes are drilled in the tube ⅛ inch from the edge and exactly on the diameter line of the tube. These holes should be made to take a 4-32 machine screw. The winding space is ½ inch and should be wound with rubber tape or some adhesive substance in order that the windings will not slip. The coil is wound with No. 20 B&S DCC wire. There are 33 turns banked 3 layers. This bank winding may be found described in a copy of THE WIRELESS AGE. Figure 4 shows the relative position of the turns on the coil. A hole is drilled at each end of the winding to pass the ends of the coil through the tube. The wire is then soldered to the brass bolts which hold the coil to the condenser leads.

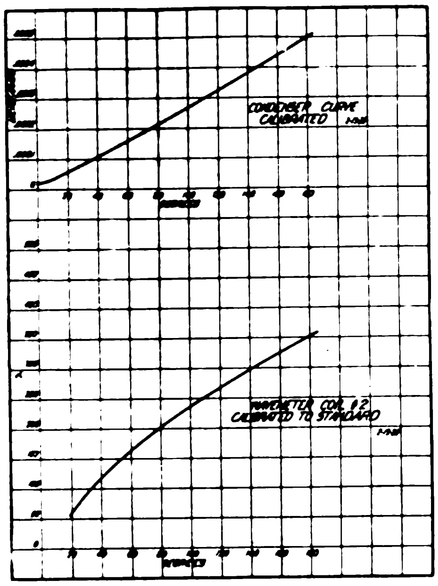


Figure 1—Graphs showing calibration of meter

The leads, figure 3, are made from 1/32 inch brass strip, ½ inch wide and 2½ inches long. One end is rounded, and drilled, for clearance of the 4/32 machine screws in the coil. The other end is slotted so that it may be easily removed from the condenser binding posts. After the leads are drilled and shaped they should be put into a vise and with a pair of pliers twisted 90 degrees, as shown in the drawing. Two leads are needed and each should be twisted in the opposite direction.

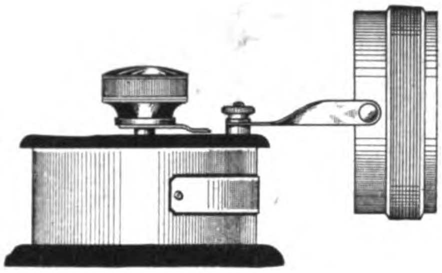
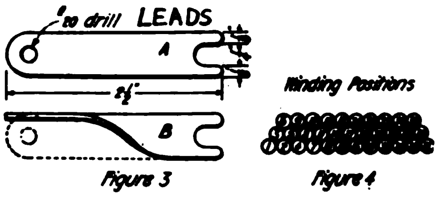


Figure 2—The inductance connected to condenser



Figures 3, 4—Constructional details of leads and method of winding the coil

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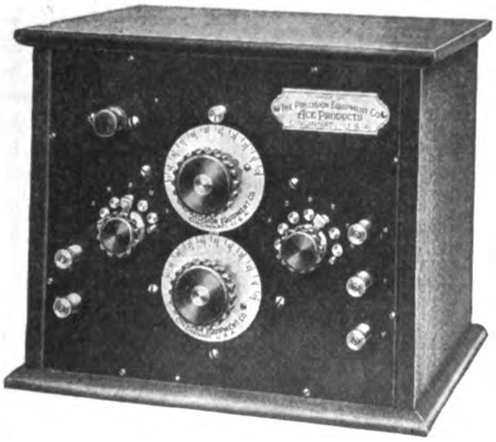

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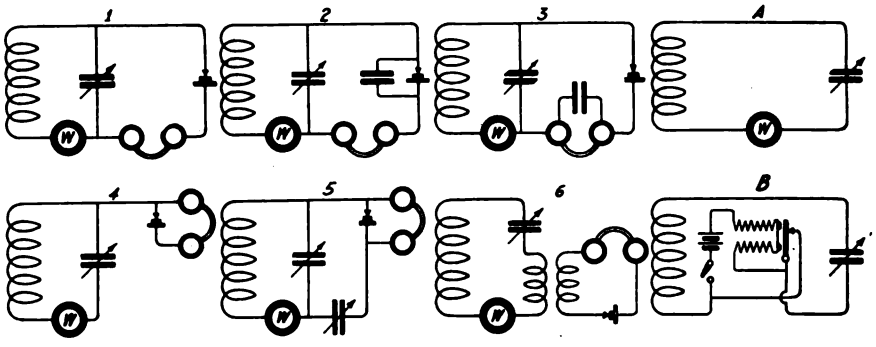
Figure 5 gives several different hook-ups for connecting the detector and phones to the wavemeter. The wattmeter or other sensitive thermometer is not used when the phones and detector are in circuit. Neither are the phones and detector in circuit when the wattmeter is used. The table of audibilities, together with the several hook-ups, as given in the Bureau of Standards Circular No. 74, is worthy of a place in any amateur's book of hook-ups.

If the experimenter owns a current squared meter or thermo-galvanometer, much finer and more accurate adjustments of the transmitter may be made. It is true that an instrument of this type is easy to read and obviates listening for the maximum note in the telephone receiver. If the lengths of leads to and from the meter are made as short as possible, no appreciable difference in wavelength indicated, will result.

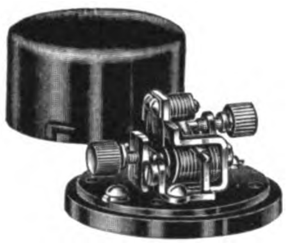
When using the wavemeter as a driver, for calibrating received signals, the circuit shown in B, figure 5, should be used. Care must be exercised, however, that the coils of the buzzer are not connected in the wavemeter circuit. This would throw the calibration of the meter to the winds. The contacts must make and break the circuit only, using the spark discharge across the contact points, to start the oscillations in the circuit. Larger coils have been made for this wavemeter, by the author, and if the reader desires data on coils of longer wavelengths, a letter will bring it.

The writer has had considerable experience in the use of wavemeters, but has failed to find one as good as this one.



Ckt. No 2—85, Ckt. No 1—55, Ckt. No 3—45, Ckt. No 5—40, Ckt. No 6—15, Ckt. No 4—10. Relative Audibility

Figure 5—Several hook-ups for connecting the detector and phones to the wavemeter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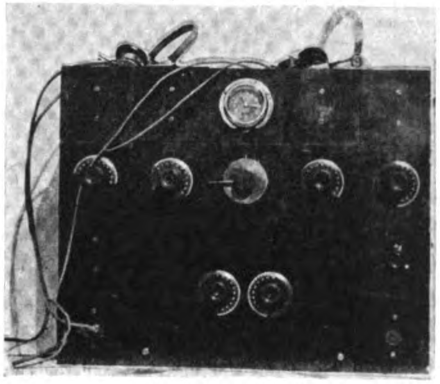

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are made of ¼ inch wood, which leaves only four and a half inches for the instrument. The cabinet for the coils can be made any size desired provided it is a multiple of five, otherwise the small sections will not fit around it. In this set, the coil cabinet was made 10 x 15 inches in order to take the largest size honeycomb coil. The gear wheels have a ratio of one to four, as the ratio of the gears on the DeForest coil holder is two to one. Thus, when the knob is turned through a half circle, the small bevel gear makes two complete revolutions and the coil swings through ninety de-

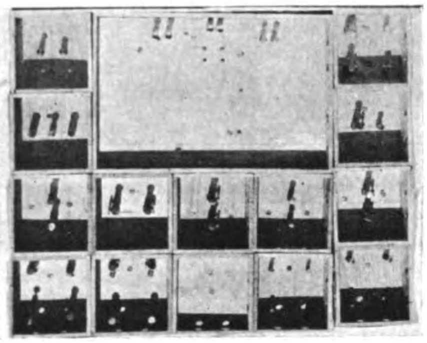

Figure 2—Rear view of the sections

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grees. These gears are made by the Boston Gear Works at Quincy, Mass., and are their number G-486, costing about $1.50 per pair. The boxes were bought from a pattern maker, but could easily be made at home if one has the tools, in which case all the side pieces should be held together and the holes drilled all at one time, before the boxes are assembled. Aluminum was used to hold the panels to the piece of wood to which the binding posts are fastened, but any other metal could be used. When the set was first designed, four strips of aluminum were to be used, one on the top, one on the bottom, and one on each side, but by using ⅛ inch hard aluminum only two strips were necessary. They were made to fit the box tightly, so that it would not be necessary to put screws or nails into the board on which the binding posts were mounted, in order to hold the instrument in the box. By using large knobs the screws holding the strips and instruments were covered up, making a very neat looking set. By setting the binding posts in an inch or so and having the holes in the sides of the boxes, it is possible to push the set up flush with the wall and have all the wiring concealed, or one condenser may be placed on end on the table and the wires brought through the holes. The boxes in this set were made 9 inches deep, but they should have been made 10 inches, as it is necessary to have 8 inches between the panel and binding post board if the set is to accommodate

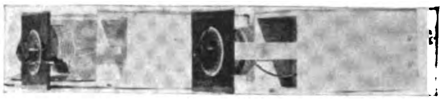

Figure 4—Two of the condensers

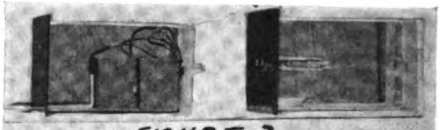

FIGURE 3

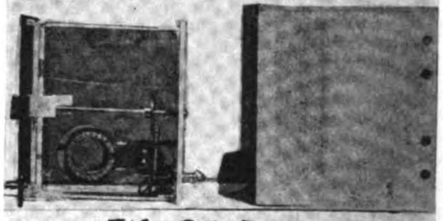

FIGURE 5

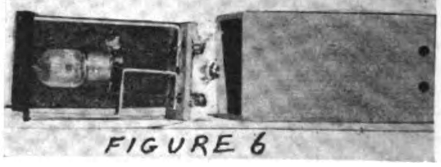

FIGURE 6

Figure 3—Batteries and phone jacks
Figure 5—Construction of tuning cabinet
Figure 6—Vacuum tube mounting

the largest size DeForest coil. However, if the coils are mounted on the outside or any other tuning arrangement is used, the boxes need not be as deep. The accompanying pictures show better than words or diagrams how the set looks.

In order to make the set most complete, all the diagrams in the various radio magazines for the last two or three years were cut out and pasted on pages of a loose leaf book, and indexed according to Crystal Receivers; V. T. Receivers; One, Two and Three Step Amplifiers; Misc. Connections; etc. By using a loose leaf book, new diagrams can be added as they appear in the latest magazines. By so doing, a hundred or more different connections can be collected in a very short time, thus giving the amateur an unlimited field for experimental work.

A Low Power Set

By Jos. PIGNONE

FOR local use, there are two sets which may be used. One is the telephone and the other the spark coil set. Each of these have their respective merits and demerits. For speed and accuracy of transmission, the wireless telephone excels. However, for original outlay and succeeding cost of upkeep, the wireless telephone equipment is out of reach of many. In addition, the operation of the telephone may also be too intricate for some amateurs. The spark coil set may seem to be a thing of the past to advanced amateurs. This is not so. If the spark coil set is properly designed, it will often do the work of a ¼ kw. set.

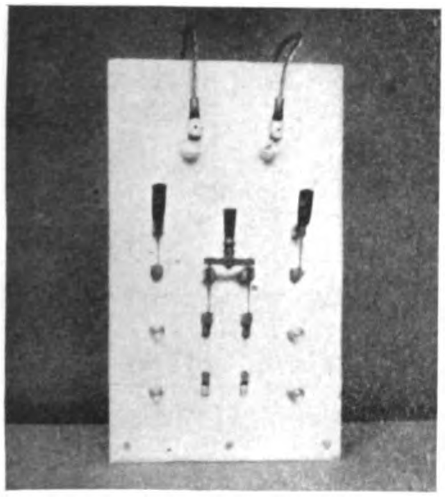

Figure 1—Front view of panel

In this case, for compactness and efficiency, the panel type was selected. The result is that the leads from the condenser are shortened considerably. The lead from the condenser to the gap is 2 inches and from the gap to the transformer 4 inches. Also the lead from the condenser to the transformer is 6 inches.

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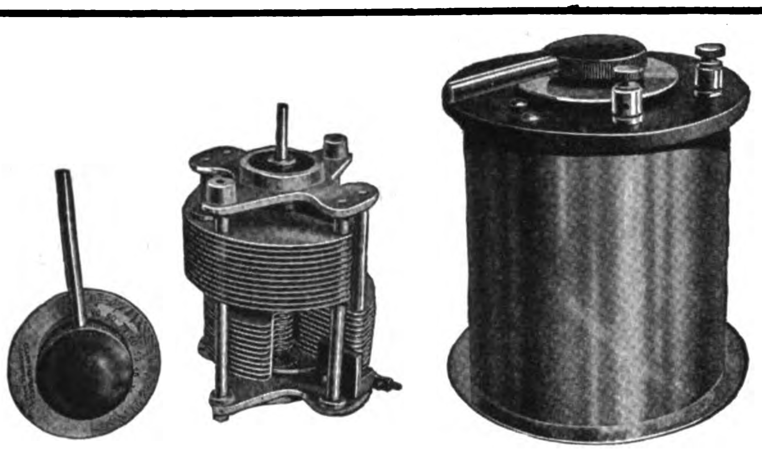

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Tresco Tuners Deliver the Goods

A TESTIMONIAL

TRESCO, Davenport, Iowa, Point Pleasant, N. J.

Gentlemen:—

Some time back you will remember that I bought a 20,000 meter coupler from you and now I wish to tell you of the wonderful results that I have had from it. I was very timid about buying this coupler, as I got stuck with a set of honeycombs, but now I am glad I got that coupler, as I wouldnot part with it for anything.

I could get results with it just as you show the hook-up, but with a little altering I got it to working so that I have heard NPL, BZR, NAR, NFF, NDD, NSS, POZ, OUI, IDO, FL, YN, LCM, and many others that I do not call to mind just at this writing. This is no bull, either; all straight stuff. I am using one bulb—a VT, 3 variables, Baldwin phones, and your Tresco coupler.

Anybody that contemplates buying one of these couplers should not hesitate, as they are the greatest thing out, take it from me. Hoping you are selling lots of these couplers and thanking you for such a wonderful instrument, I am,

Yours very truly,
R. VAN CAMP, Radio Station 2VC.

The make of the apparatus used will be mentioned to facilitate the procuring of them. The spark coil employed in this set is a "Ford" ignition coil. Amateurs in and about New York have been getting very satisfactory results with these coils. They give a fat spark, and a pleasing note if properly adjusted. The condenser used is a small "Dubilier" .004 mfd mica. This was chosen because of its compactness. However, a small oil condenser slightly larger can be constructed to replace this. The spark gap can easily be made. It may be of any design, but the one shown, with ¼ inch electrodes works best with this coil. Lastly, the transformer — having an oscillation transformer with variable coupling would be of no advantage, as the energy involved is so small. A pancake or a cylindrical coil may be used, and in the set illustrated the cylindrical type was selected only because the bakelite strips for such a coil were handy. This unit is 7 inches in di-

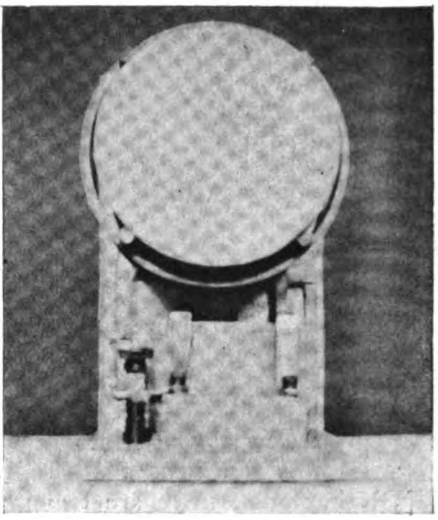

Figure 2—Rear view

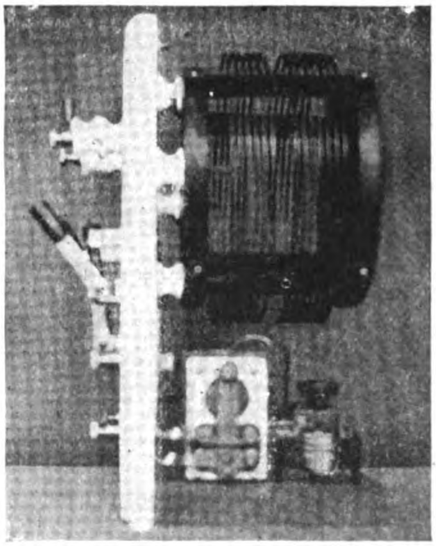

Figure 3—Side view

ameter wound with edgewise strip. Eight turns comprise the primary and the same number the secondary. The turns are spaced ⅛ inch apart. The primary and secondary are spaced ½ inch apart.

The panel is 7 x 12 inches and the base attached to it is 7 x 6 inches. On the face of the panel are mounted the proper control switches. The double-pole switch is for the power supply, which is 6 volts; the single-pole switch on the left is to short the key and the one on the right is to short the vibrator. The reason for having the single-pole switch is that the builder might wish to experiment with synchronous interrupters. Also, for tests, the set might be used continuously. The aerial and ground leads are brought to the front of the panel.

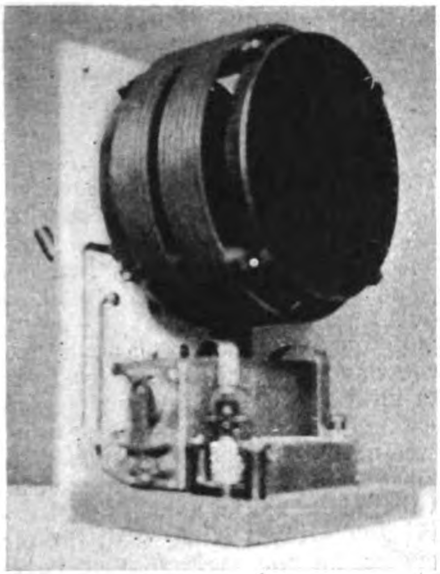

Figure 4—View of the oscillation transformer

It is useless to state the transmitting radius of such an equipment, as local conditions vary too greatly. However, with the author's set, 25 miles have been accomplished.

Correction March "Age"

In the diagram printed on page 37 of the March issue, a grid condenser should have been shown between the crystal detector connection and the grid.

Winner of Wireless Contest

James Collins, of Cleveland, was awarded the special prize—a $150 wireless receiving outfit—in the wireless contest conducted by The Press, in co-operation with associated newspapers throughout the country.

Collins was awarded the prize for his essay on "The Wireless Amateur." He is 18 years of age and is about to enter college.

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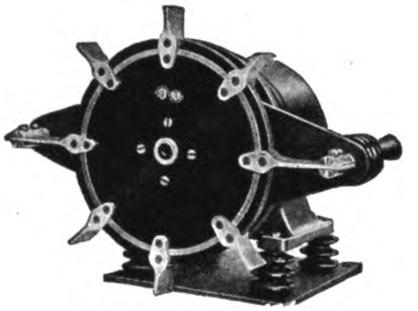

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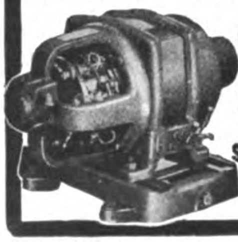

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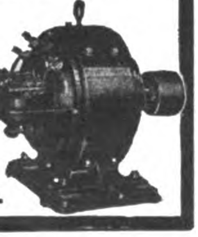

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Backing Up Geagan

P. F. GEAGAN'S article in the April issue on "Getting Results" was sure interesting; it has undoubtedly been read and digested by everybody, regardless of whatever else they may have passed up.

While it might seem to a casual peruser that Mr. Geagan is inclined to wax sarcastic at times, none can deny that the things he brings to our attention are appropos, and if put into practice, will, without doubt, result in a vast increase in efficiency and in the satisfaction we obtain from listening to what the "Wild Waves" are saying (a la ACE).

My first wireless set, constructed back in the medieval times when the art was new, consisted of a coherer, with its attendant bell and tapper; a dishpan, hung out of the window for an antenna; and three dry cells, salvaged from a neighbor's auto for a source of power for the de-coherer. The station which I had hopes of hearing was New York, about 150 miles away, and when after an hour nothing came in, in spite of all possible adjustments, I decided that they were not sending. Possibly they weren't. I don't know.

Of course, I now have a really excellent audion panel, with which I can get un-damped "stuff" without either heating the tube with a match or using three or four 3-foot tubes of No. 36. But in spite of the things I can get on it, there is lacking the thrill that I experienced while waiting with the old coherer for the message that never came. Familiarity breeds contempt, we are told, and nowhere does it apply more than in the wireless game. My best regards to Geagan for a long life, and may his bump of humor never grow less.

Whoever wrote "Clean English in Wireless," too, should know that the large majority of bugs are with him, and will back him up in anything he tries to do to eliminate the objectionable conversations to which we have most of us listened at times.

Good luck an' everything.

B. R. Wedemann.

Queries Answered

Answers will be given in this department to questions of subscribers, covering the full range of wireless subjects, but only those which relate to the technical phases of the art and which are of general interest to readers will be published here. The subscriber's name and address must be given in all letters and only one side of the paper written on; where diagrams are necessary they must be on a separate sheet and drawn with India ink. Not more than five questions of one reader can be answered in the same issue. To receive attention these rules must be rigidly observed.

Positively no questions answered by mail.

J. F. T., Kingsbridge, N. Y. C.:

In order to get the 25-mile radius with the radiophone outfit which you mention, it would be necessary for you to use a 400-volt generator. A 60-volt B battery would probably reduce your radius to something like 3 or 4 miles.

H. K., N. Y. C.:

In reply to your query requesting information which will enable you to construct a radiophone having a radius of 4 miles using 75 volts in the plate, we refer you to a recent article published in this magazine covering the construction of a 25-mile radiophone set.

With the hook-up which you show, you should be able to cover this distance providing everything is working properly. You do not show in your hook-up any meters for determining the radiation which you are getting. Using a rectified 350 volts, the distance which your outfit will cover should be in the neighborhood of 15 to 20 miles. In order for you to know what results you are getting, however, you should provide yourself with a radiation meter having a maximum range of about one ampere.

* * *

A. W. S., Billings, Mont.:

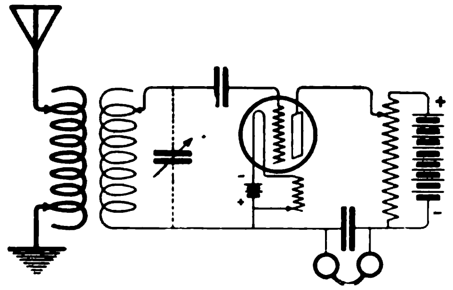
The Adams Morgan Co. is located at Montclair, N. J.

It will be impossible to tell you what size to make the primary loading inductance for your receiving transformer, unless we know what wavelength you wish to load up to, as well as the size of your receiving transformer. Neither can we advise you as to the construction of a tickler coil without some information as to the wavelength range of your receiving transformer, as well as the size and form of the secondary coil.

* * *

G. W. H., Chicago, Ill.:

We print herewith a diagram showing a hook-up for your loose coupler and auxiliary apparatus.



M. J. S., N. Y. C.

You should be able to obtain a copy of The Phillips Code through J. H. Bunnell & Co., New York City, or through the Telegraph Age. It will cost you about $1.50.

* * *

H. F. K.:

Figure 1 of the article by C. R. Leutz, which was printed in the April number, should be corrected so that the left hand filament connection of tube No. 1 and the right hand filament connection of tube No. 4 come to the negative terminal of B-1.

* * *

C. R., Valdosta, Ga.:

We are unable to tell you where it will be possible for you to obtain a ½-kw. open core Marconi transformer. We suggest that you advertise in some of the radio magazines. It may be that some amateur now has one which he would be willing to dispose of.

The efficiency of Leyden jars as condensers is usually somewhat greater than the efficiency of a plate glass condenser, due to the fact that a better grade of glass is used in the Leyden jar.

We regret that we are unable to advise you as to the power input of the new station at Savannah, Ga.

We have insufficient data at hand at the present time to enable you to construct a magnetic detector.

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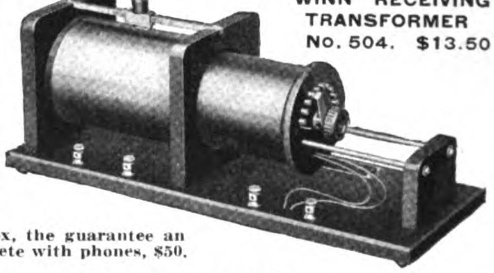

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Our Detector is in a class by itself and is the outcome of long and careful experiments to produce an article which does away with all the objections of the ordinary Detector. Enclosed in glass, dust-proof cylinder, which keeps the mineral clean and free from vibrations. This feature alone bears out our claim for general excellence of any and all "WINN" apparatus, all HI-GRADE.

Your dealer will supply you with any "WINN" HI-QUALITY Wireless Apparatus. If not send his name and we will see you are supplied promptly. Write for our "Supplement A" advance catalog, which contains complete information about the entire "WINN" HI-QUALITY Radio goods. It's FREE.

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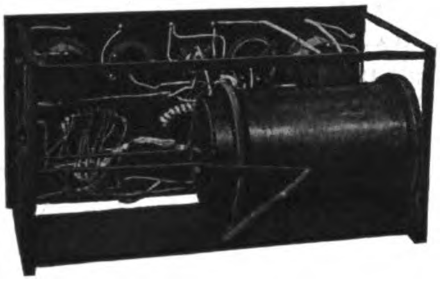

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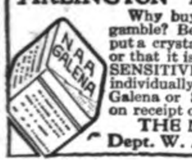

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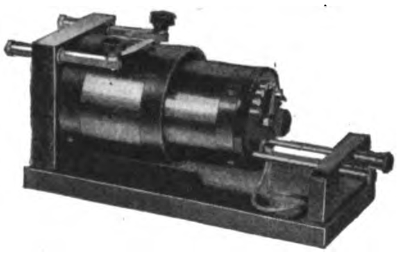

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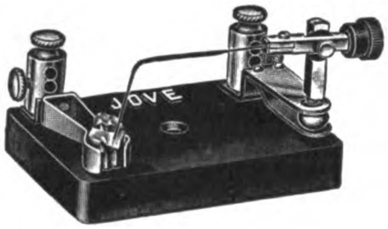

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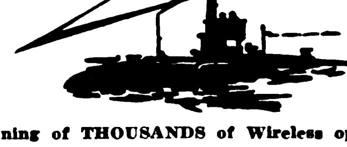

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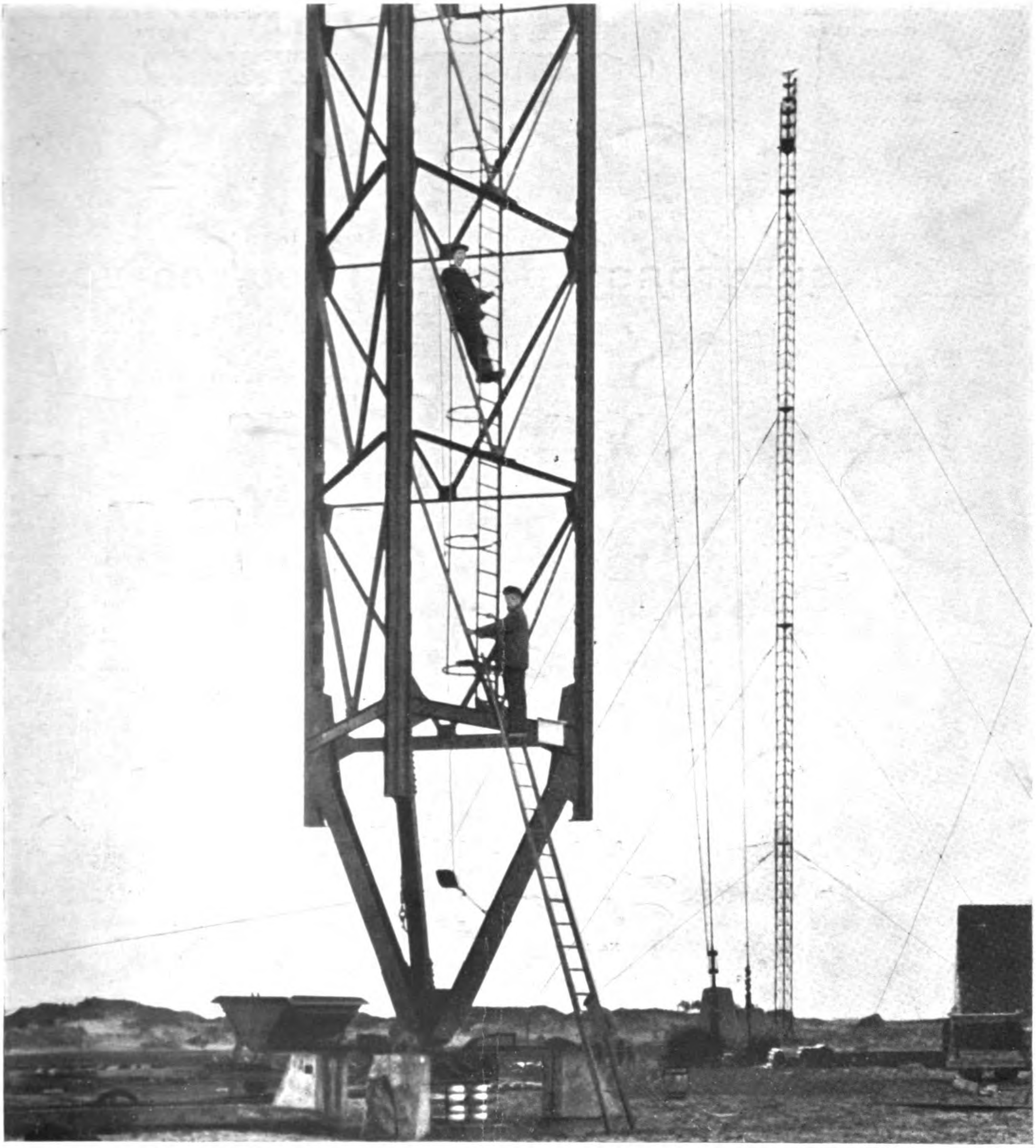

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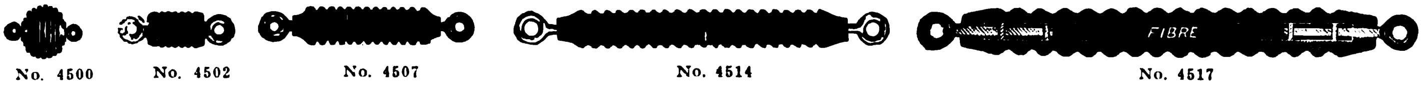

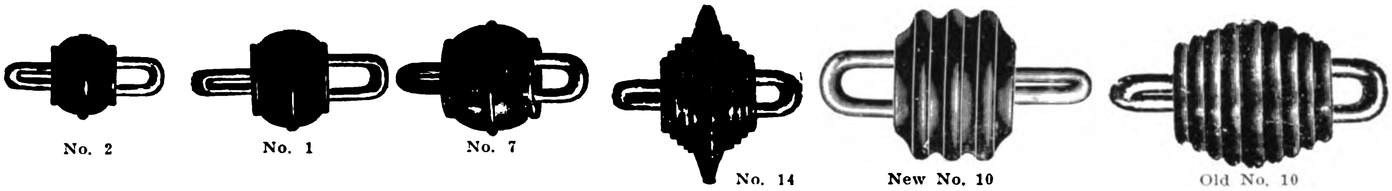

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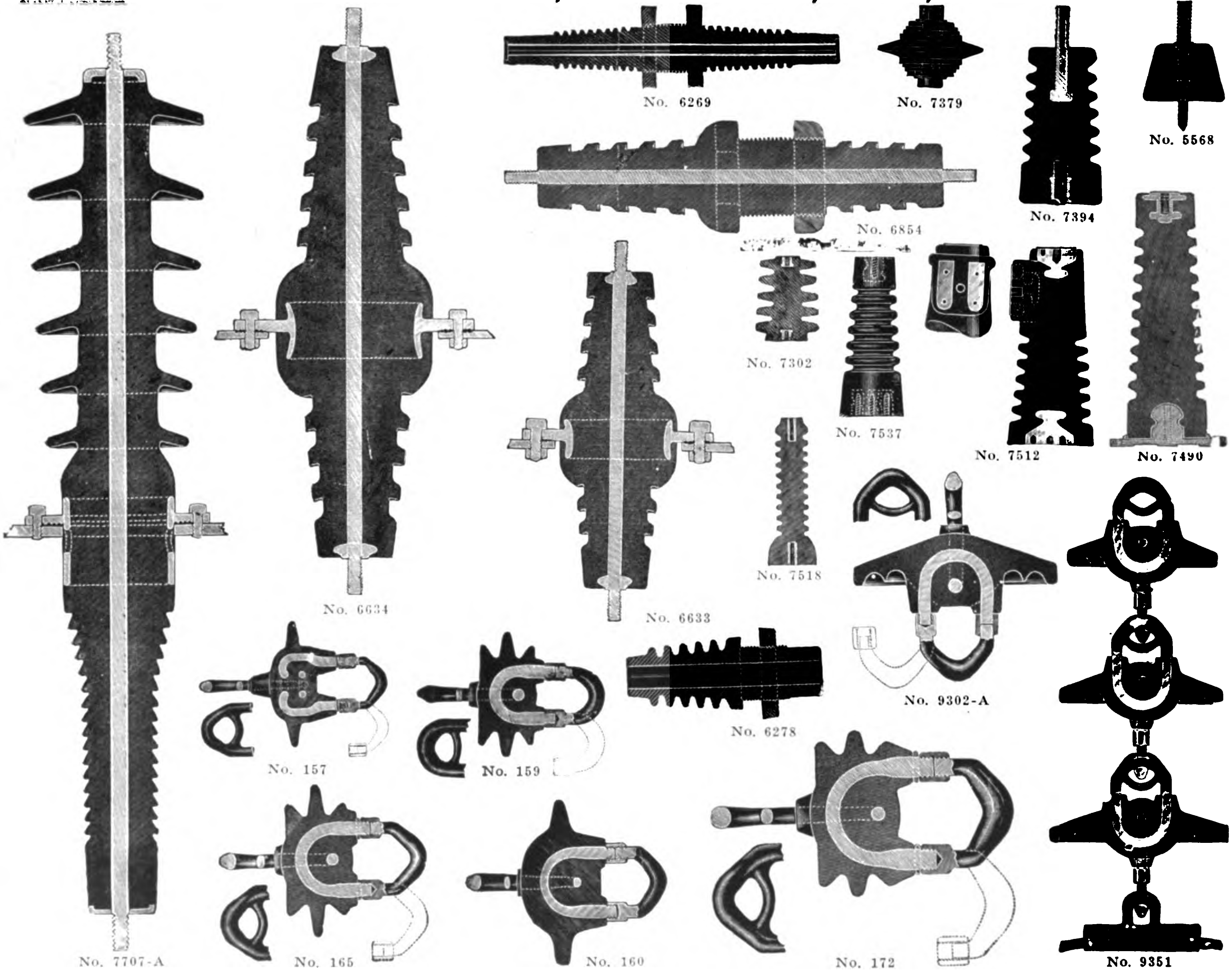

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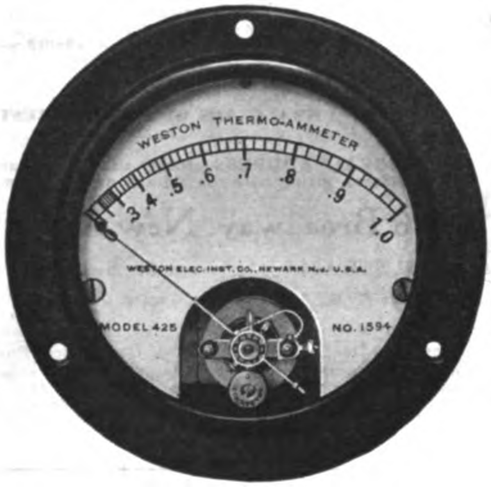

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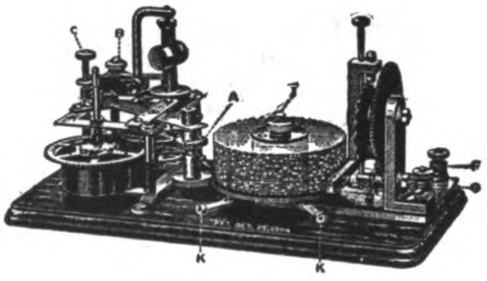

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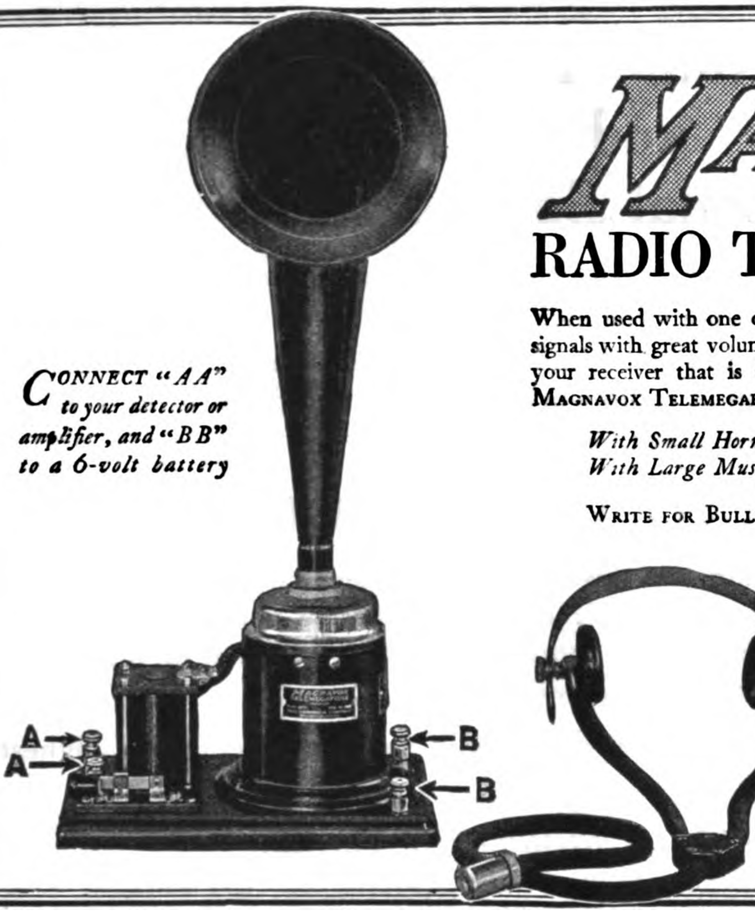

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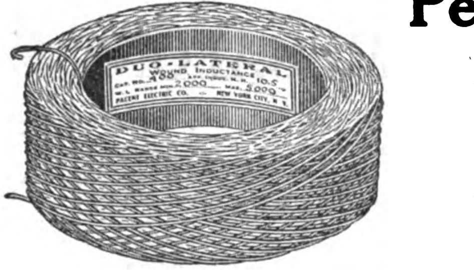

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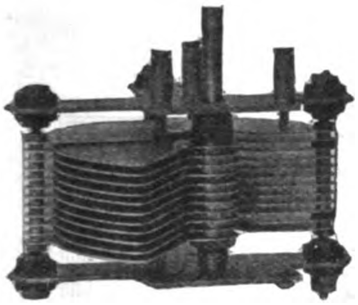

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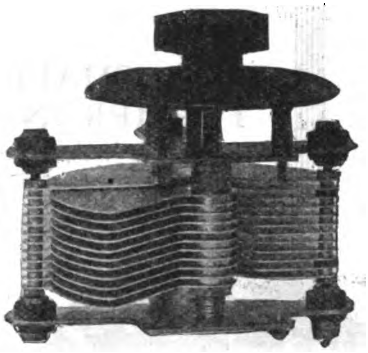

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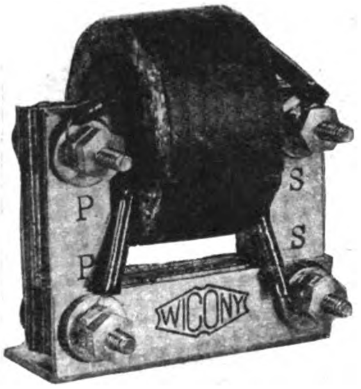

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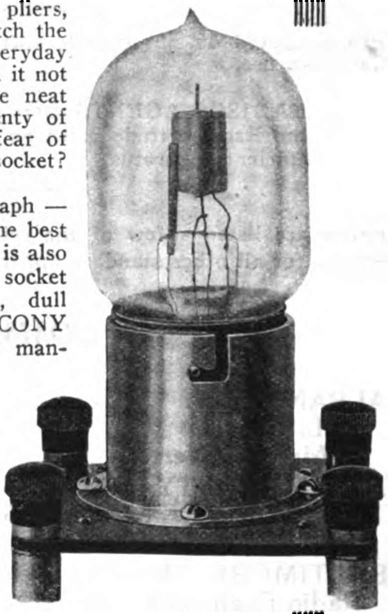

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WIRELESS IMPROVEMENT COMPANY

INCORPORATED
Radio Engineers, Manufacturers and Distributors
47A West Street New York, N. Y.

If this page is cut out and appended to the same page cut from the editions to follow, a complete file of very interesting information will soon be available. (No. 7)

Vol. 7. No. 10. July, 1920

WORLD WIDE WIRELESS

Thousand-Word-a-Minute World-Wide Radio Station

THE world's biggest wireless plant, to be built at Rocky Point, L. I., by the Radio Corporation of America, will handle 500 words in and 500 words out a minute, simultaneously, the land wire relay of seventy miles from Rocky Point to the company's office in Broad Street, New York City, being controlled mechanically, the human element entering into the process only at the point of actual transmission.

Mr. Edward J. Nally, President of the Radio Corporation, announces that the company plans a $10,000,000 plant on a 6,000-acre tract about seven miles from Port Jefferson.

"We are going to erect," he said, "five units, with another one to be held in reserve for use in the emergency of severe storm or other trouble. Each of the units will have a minimum capacity of sending 100 words a minute and of receiving the same number. This is, of course, the minimum capacity. We are hopeful, however, of doing better than this when the plant is fully geared up.

"To get an idea of the projected plant you might fancy it laid out as a wheel. The big power house represents the hub, while the spokes or wings, twelve in all, radiate out in all directions from the power house. Each wing will have six antennae strung to 400-foot steel towers.

"It is our plan to transfer the wireless signals directly from the wireless apparatus to land wires and send them right along into New York City, to headquarters, without calling manual labor into the process at any time. We are going to have a radio receiving station about seven miles from the transmitting station, and we plan to operate both simultaneously.

"It is the design to control relays entirely from our city office. All of the operating work will be done there, although the machinery of transmission will be, of course, out at Rocky Point.

"Each of the five units of the plant will serve a separate field. One will be in touch continuously with South America, another will talk to Germany, a third will serve France, another goes to Italy and the fifth will serve Poland."

The third transoceanic wireless circuit, linking America with the rest of the world, has been opened by the Radio Corporation. Opened principally for commercial messages, the new wireless route connects this country with the Scandinavian countries—Norway, Sweden, Denmark and Finland. The American stations, at Marion and Chatham, Mass., with their complementary stations at Stavanger and Naerobe, Norway, are of the duplex type, sending and receiving simultaneously at high speed.

It was announced that the rates for the new service, from New York City to any point in the countries named, would be, per word, Norway, 24 cents; Sweden, 26 cents; Denmark, 28 cents, and Finland, 29 cents. It was stated that these rates were from 30 to 50 per cent. lower than existing cable tolls. The other commercial circuits in operation by the Radio Corporation are from San Francisco to Japan, via Hawaii, and from New York to Great Britain.

London Daily Mail Has Radiophone News Service

WIRELESS telephone receiving set has been installed in Northcliffe's Daily Mail. The paper hopes to have its American news dictated by 'phone from New York in the very near future.

Keystone

Danish wireless commission to U. S. Left to right—Capt. H. Faber, Prof. P. C. Pederson, Commander H. J. Schledermann, Hon. T. F. Krarup and W. G. Thomson

Marconi Has 500-Mile 3 K. W. Radiophone

WIRELESS telephone communication over a distance of 500 miles, with apparatus of a strength of only three kilowatts, has been achieved by William Marconi, the Italian inventor. This was announced upon his return to Rome from a cruise in the Atlantic and Mediterranean on board the yacht Electra.

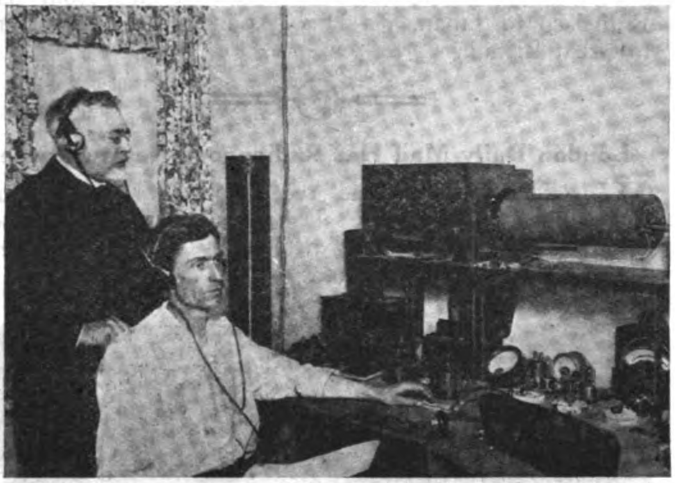
Albany Firm to Use Radiophone

THE Esco Electrical Company, of Albany, N. Y., has erected a powerful wireless telephone set in its Broadway store. It will use the radiophone method of communication with its agents in New York and other places as soon as the operation of the instruments is perfected to a point where such points can be reached. Carl Hoffman, employed by the company, is conducting tests in an effort to increase the working distances of the instruments. Already he has established communication with wireless operators at Troy and Schenectady. The firm especially wishes to be able to talk with New York.

Marconi Explains Radio to Spanish Workers

SENATOR GUGLIELMO MARCONI, who is known for his amiable qualities almost as much as for his great invention, has just given another proof of his urbanity. Despatches from Seville, Spain, where he stopped with his yacht Electra, state that a large party of laborers approached the yacht and requested permission to see the wireless apparatus on board. In the absence of the owner the officer in charge refused to grant the permission.

Just as the men were leaving Marconi returned to the vessel and, having been informed of their desire, he invited them aboard and personally explained to them in all its details the working of the wireless apparatus.



Keystone

Dr. Frederick Millener (standing), scientist of Omaha, trying to catch Mars wireless signals by means of special apparatus

Radiophone Talk Recorded on Phonograph

EXPERIMENTS which have been carried out in London have resulted in the making of a talking machine record on wax of a voice transmitted by wireless telephone forty miles away.

While the voice was speaking at Chelmsford, in the County of Essex, where there is a high-power instrument capable of transmitting the voice many hundreds of miles, the equipment at the receiving plant in the Strand, London, was attached to a recorder, which engraved the messages in soft wax in the same way as an ordinary talking machine disk is manufactured.

The record when produced was perfectly audible.

Commercial Application of Radiophone

THE Public Service Company of northern Illinois is installing wireless telephones at its Blue Island and Joliet stations, the intervening distance as the crow flies being only about 25 miles. The two stations tie-in together and also are interconnected with the Fisk and Quarry Street stations of the Commonwealth Edison Company in Chicago. The wireless system will have a radial power of about 100 miles, and will be used primarily during such times as the metallic telephone lines are out of service, due to weather or high-voltage system trouble.

Radio Service Between Germany and Spain

PRESS dispatches may be sent between Germany and Spain by wireless, according to an announcement made lately. Most German correspondents, however, have left Spain and consequently the service will be used principally for German propaganda, it is asserted.

Danes Seek Direct Wireless Connection With U. S.

THREE officials of the Danish Government arrived lately to confer with Washington officials regarding the establishment of a direct wireless communication between the United States and Denmark, to facilitate commercial communication between the two countries. A great trans-Atlantic wireless station has been established in Denmark of sufficient range to transmit messages direct across the Atlantic.

When this channel of communication is firmly established, commercial messages will no longer be routed via Great Britain.

Commercial Company to Use Private Radiophone

THE new Winchester stores in the New England States may be connected by wireless and all their business so transacted. Officials have consulted W. J. Butterworth of Boston, assistant federal radio inspector for New England, in regard to the proposed enterprise.

The Winchester company is considering the use of the wireless stations largely on account of the delays caused by wire troubles. This situation was particularly noticeable during the last winter. Often in very severe weather, when the telegraph and telephone lines are out of commission, the weather conditions are especially favorable for wireless. Moreover, the increasing improvement of the radiophone has added greatly to the possibilities of wireless, and radio communication would also be advantageous in that messages are simultaneously heard in all directions and hence at one time the headquarters of a company could transmit orders and information to all branch offices within a radius of one hundred miles.

Whole World to Get Wireless Time Signals

WIRELESS telegraphy may yet prove to be the means of preventing many railway and sea catastrophes. To this end in fact an International Time Bureau is being formed in Brussels, which intends to develop methods of transmitting throughout the world the time signals of the greatest precision.

The bureau is in charge of M. Bigourdin, member of the French Academy of Sciences, who for many years has been attached to the Paris Observatory. Discussing the aims of this new organization M. Bigourdin has called attention to the fact that all through the war the Eiffel Tower sent daily signals that were picked up in the most remote quarters of the globe.

"It is most essential that navigators know at every instant the precise time," says M. Bigourdin. "Extensive experiments have been carried out in the last year and we have reason to believe that the efforts will lead to unexpected discoveries concerning the variations in actual longitude similar to those known to exist with respect to latitude. With precise knowledge of the time, the sun's location and the consequent geographical position ships will more easily avoid dangerous areas."

M. Bigourdin is confident that many sea accidents have been due to the impossibility of ships picking up accurate time signals. He points out also the necessity for the most reliable records for despatching trains in all countries. Further experiments will be conducted with intermittent Hertian waves approximately 2,600 metres long to replace those of shorter length now used.

M. Bigourdin, whose investigations are receiving support in all allied countries, hopes to create a system whereby the expenses will be distributed among all nations, for it is obvious that once the signals begin to work there is nothing to prevent any mariner from taking advantage of an organization in which French scientists are taking an important part in putting into operation.

Transpacific Steamship Lines Plan Radio Charts

STEAMSHIP lines operating in the transpacific trade are planning to take advantage of the chain of powerful wireless stations, which extend along the Alaskan Coast from Juneau to Dutch Harbor and to St. Paul Island, making possible permanent wireless communication with the Orient from Seattle and other North Pacific ports.

The importance of taking advantage of these radio stations in communicating with ships at sea and in transmitting messages from Seattle to China and Japan, has been emphasized by the serious delay to cable messages, now ranging from 150 to 160 hours.

Representatives of the Nippon Yusen Kaisha are preparing maps for use aboard the vessels of the N. Y. K. transpacific fleet and in the company's offices both in the Orient and America, showing the position of the stations and the possibility of constant communication with a vessel of the fleet from the time she sails from Seattle until she berths in Yokohama. This is made possible by the radio stations in Juneau, Sitka, Cordova, Kodiak, Dutch Harbor and on St. Paul Island.

The most powerful of the stations is the one in Cordova, which has a radius of 2,000 miles in the daytime and 4,000 miles at night. The distances the other stations can work follow: St. Paul station, 1,000 miles in daytime and 2,500 miles at night; Dutch Harbor, 300 miles in daytime and 600 miles at night; Kodiak, on Kodiak Island, 1,000 miles in daytime and 2,000 miles at night; Sitka, 1,000 miles in daytime and 2,500 miles at night; Juneau, 500 miles in daytime and 1,000 miles at night.

With the present wireless arrangements of the transpacific steamship lines, the first communication with a ship at sea bound from the Orient for this coast is had when the vessel arrives within 1,000 miles of Victoria, B. C.

Radio Masts Snapped Passing Under Brooklyn Bridge

THE radio masts of the U. S. collier Nereus were snapped off as the ship passed under the middle span of the Brooklyn Bridge on her way to the navy yard recently. The fragments of the masts fell to the deck of the ship, where they narrowly missed hitting some of the crew.

The Nereus arrived from France with the bodies of sailors and marines who had died overseas.

Jap Navy to Use Wireless 'Phone

THE Japanese Navy will no longer depend on radio telegraphy for communication as a result of the perfection of the wireless telephone, which hereafter will take the place of all other forms of signaling.

An official of the Ministry of the Navy said that the new wireless telephone apparatus had been installed on the vessels of a unit of the First Squadron and was being installed on the rest of the Japanese war ships.

Radio Rates to Japan Reduced

TO offset the rising price of necessities, comes the announcement that the high cost of sending wireless messages from Seattle to points in Japan has dropped. The rate now from San Francisco to Tokio is 72 cents a word instead of 80 cents. W. F. McAuliffe, local manager of the Radio Corporation of America, gave this information and declared that within a short time messages destined for the Orient from Seattle will be accepted by messenger boys in the same manner as ordinary telegrams are delivered.

Many will give three rousing cheers, it is said, when they learn that a night letter to the Emperor of Japan, say of fifty words, instead of costing $40 as formerly, will now cost but $36.

The cut in the rate of wirelessing Japan, says Mr. McAuliffe, is made possible by the opening of a new 400-kilowatt station at Haro-no-machi, in the vicinity of Sendai, on the Northern Japanese mainland. This station, with high frequency alternator type equipment, will work directly with the Pacific Coast stations of the Radio Corporation.

Keystone

Erecting the receiving loop on the N. Y. Times Bldg., with which it was hoped to receive radiophone messages from warships entering the harbor

"Traffic schedules are being worked out so that Seattle firms will shortly be able to file their business locally, the same as any other ordinary telegraph message," said Mr. McAuliffe. "For the immediate present, however, messages are accepted only in San Francisco, Seattle messages to Japan going through San Francisco by the wiring of messages from Seattle to San Francisco."

U. S. Radio Examinations

THE United States Civil Service Commission announces open competitive examinations for radio engineer (aeronautics), $3,600 to $5,000 a year; assistant radio engineer (aeronautics), $2,500 to $3,600 a year, on July 6, 1920. Vacancies in the Air Service at Large at the salaries indicated, and in positions requiring similar qualifications, at these or higher or lower salaries, will be filled from these examinations, unless it is found in the interest of the service to fill any vacancy by reinstatement, transfer, or promotion.

Competitors will not be required to report for examination at any place, but will be rated on the following subjects, which will have the relative weights indicated:

Subjects—Physical ability, 10 weights; education, experience, and fitness, 90 weights. Total, 100 weights.

Competitors will be rated upon the sworn statements in their applications and upon corroborative evidence. For the position of radio engineer, applicants must have graduated with a B. S. degree, with major courses in physics or electrical engineering, from a college or university of recognized standing; and, in addition, have had at least three year's experience in the design, manufacture, or installation of radio apparatus for the Government or for a contractor who has supplied satisfactory apparatus of this class to the Government.

For the position of assistant radio engineer, applicants must have had the education and one year of the experience prescribed for radio engineer.

"WII"—New Brunswick

The Alexanderson Continuous Wave System—Description of the High Power Radio Apparatus for Radio-Telegraph and Radio-Telephone Transmission

By Elmer E. Bucher

Commercial Dept., Radio Corporation of America

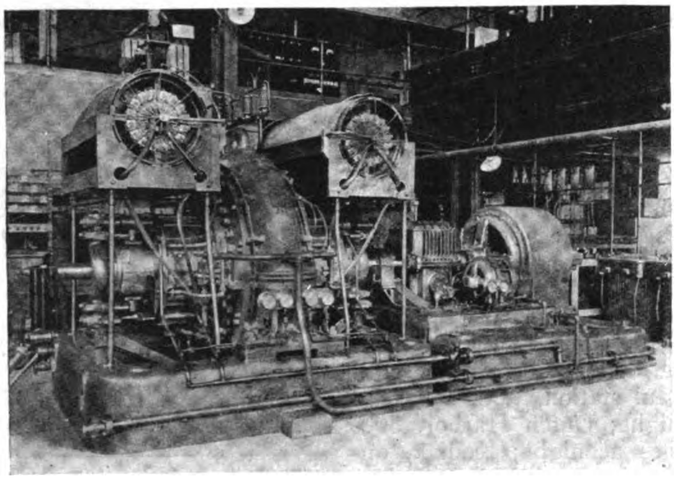


Figure 1-2—200 kw. Alexanderson radio frequency alternator installed in the New Brunswick transoceanic station

RADIO engineers early foresaw that the ultimate generator of oscillations for radio-telegraphy and telephony would be one of a type providing more efficient and reliable operation than the systems utilizing the "arc" and "spark." In fact the literature of the past makes frequent references to the desirability of an oscillation generator constructed along the lines of an ordinary power-house alternator; but because such alternators were required to provide frequencies a thousand times or more in excess of those used in power engineering, new problems of design were encountered which were declared by many to be well-nigh insurmountable.

For a time the development of the art seemed to follow the line of least resistance, and it resulted in the evolution of several systems utilizing the "arc," the "spark gap," and the type of radio frequency alternator which generates at a comparatively low frequency, the necessary increase of frequency being obtained either by groups of mono-inductive transformers external to the alternator, or by tuned "reflector" circuits associated with the alternator. None of these systems, however, can be said to have satisfied fully the exacting requirements of commercial operation.

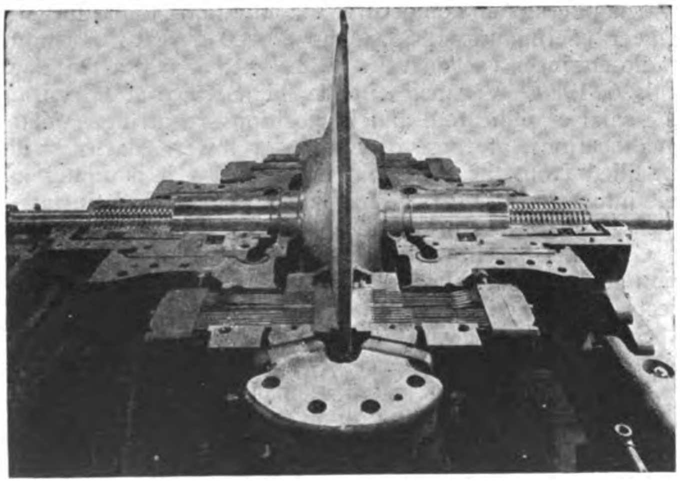


Figure 3—Alexanderson alternator with top half removed

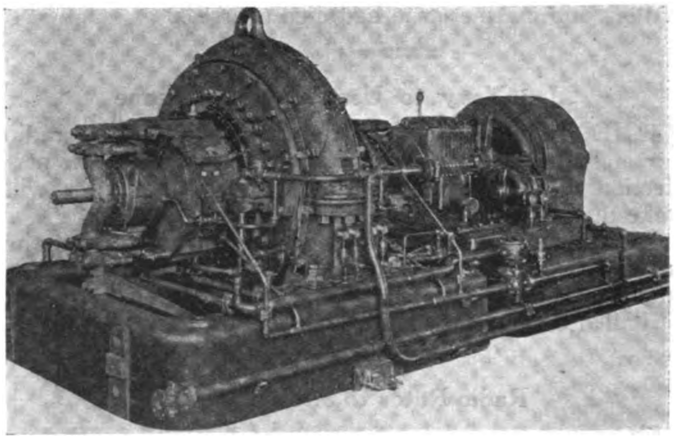


Figure 4—Alexanderson alternator with high frequency transformer removed

An oscillation generator suitable for commercial radio service over great distances, should possess the following qualifications:

1. It should generate a steady stream of oscillations of constant amplitude.
2. It should generate a so-called "pure" wave; that is, a fundamental wave in which the radiation incurred by super-imposed harmonics is negligible.
3. It should provide a performance as reliable as the ordinary power dynamo.
4. It should operate economically and efficiently.
5. It should permit manufacture of units in any desired power.
6. The design of the whole system should be such as to permit telegraphic signaling at very high speeds.

These specifications are met fully and fairly in the Alexanderson system.

As is well known, the design of radio frequency alternators has occupied the attention of Ernst F. W. Alexanderson of the General Electric Company and his staff for a number of years, and the pioneer work of these men in that branch of radio research is now a matter of common knowledge. Starting with the development of several experimental types of alternators, they have steadily progressed toward the designs of more powerful machines which are now available for commercial use. Standardized alternator sets for transmission at wave lengths between 6,000 and 10,000 meters and between 10,500 and 25,000 meters, are now in production. This description is devoted principally to the discussion of a 200-kilowatt set, although sets of other powers are now under construction.

The typical Alexanderson high-power station may be said to represent a radical departure from current ideas regarding radio design. In fact, at first glance, it seems to possess little in common with the apparatus of other systems. These features will presently be described in greater detail.

The Radio Corporation, after an extensive test of the Alexanderson system at its high power station at New Brunswick, N. J., has acquired the rights to the Alexanderson system, and it will be employed at all its stations devoted to long-distance signaling. A 200-kilowatt alternator set was installed at New Brunswick in September, 1918, and from that time it has provided continuous and most satisfactory service in continent-to-continent communication. Normal transmission is at present conducted at the wave length of 13,600 meters, with antenna current of 400 amperes corresponding to an alternator output of approximately 80 kilowatts. With this fractional value of the available output of the alternator, trans-oceanic communication has been maintained with European stations throughout the twenty-four hours of the day. The alternator is capable of supplying 600 amperes to the New Brunswick antenna, but its full output of 200 kilowatts is not at present utilized, due to the lack of adequate power supply at that point. The alternator, as installed at the New Brunswick station, is shown in figure 1-2.

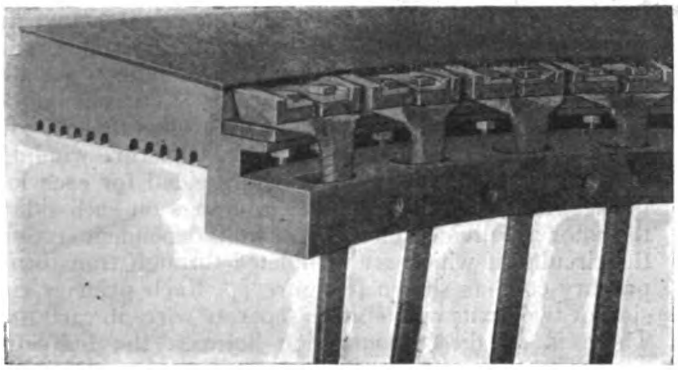


Figure 6—Detailed view of section of armature

The following explanation of the basic principles of the Alexanderson System and the fundamental circuits of a typical station may be accepted as indicative of a standard 200-kilowatt installation, although largely based upon the apparatus at the New Brunswick station.

A high power radio station of the Alexanderson type contains three important developments:

(1) An alternator—which generates currents directly at the frequencies which are required for the radio circuits with which it is associated. The frequency of these currents is solely dependent upon the number of field poles on the machine, and upon the speed at which the rotating member is driven. This is in distinct contrast to certain other systems in which the radio frequency currents are obtained indirectly by means of "reflector circuits" or frequency raising transformers electrically associated with the alternator.

(2) A magnetic amplifier—which provides a non-arcing control of the alternator output for radio telegraphy, and is equally applicable to radio telephony.

(3) A multiple tuned antenna—a development which has markedly reduced the wasteful resistance of the flat-top antenna, and has therefore increased the transmitter overall efficiency many fold.

To date the development in radio alternators has included the following types:

2-kw., 100,000 cycle; 50-kw., 50,000 cycles; 200-kw., 25,000 cycle.

The characteristics of several alternators of other power outputs have been investigated from time to time. A standard 25-k.w. and a 5-k.w. alternator are now under construction and will be shortly put into commercial production.

With the object of providing a distinct range of frequencies, both the 25-k.w. and the 200-k.w. alternators are manufactured with armatures and rotors with different numbers of poles; also with gears of different ratio for different driving motor speeds. Thus the 25-k.w. machine can be assembled for any wave length from 6,000 to 10,000 meters, and the 200-k.w. machine for any wave length from 10,500 to 25,000 meters. Frequencies lower than these for which the machine has been assembled can be obtained by running the alternator at a reduced speed.

The standard drive for the 200-kw. Alexanderson alternator is two-phase, 60-cycles, 2,300-volt alternating current. By the use of suitable transformers, the voltage of the power supply can readily be transformed to the value for which the motor was designed. Special driving motors and control equipment can be supplied for frequencies other than 60/50 cycles.

The Alexanderson alternator is an inductor type of generator with a solid steel rotor having several hundred slots milled radially on each side of the rim. The slots are filled in with non-magnetic material, with the object of reducing wind friction to a minimum. The fillers are brazed into the disc in order that they may withstand the centrifugal strain of rotation. The rotor is designed for maximum mechanical strength by providing it with a thin rim and a much thicker hub. With this construction the strain on the material due to centrifugal force is the same from the shaft to the outer rim.

The rotor of the 200-k.w. alternator—with half of the field frame removed—is shown in figure 3. This also shows the collars of the thrust bearings and a partial sectional view of the main bearing housings.

An assembled 200-k.w. alternator with its driving motor is shown in figure 4. The alternator is driven by a 600 h.p. induction motor of the wound-rotor type, which is operated from a 60-cycle, 2,300 volt, quarter-phase source of supply. The motor is connected to the alternator through a double helical gear—with a speed step-up ratio of 1 : 2.97—which operates in a container partially filled with oil.

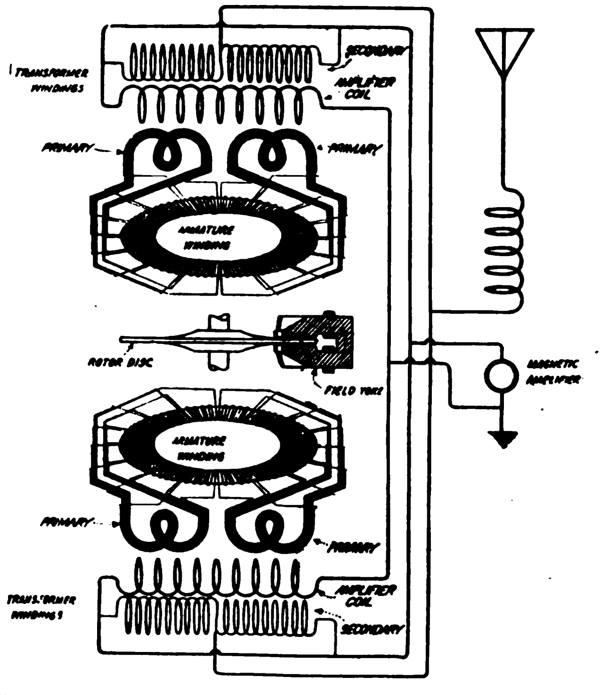


Figure 5—Schematic diagram of Alexanderson alternator circuits

The main bearings and the thrust bearings of the alternator are oil-lubricated by force feed at pressures varying from 5 to 15 pounds according to the demand on the bearing. During the periods of stopping and starting, and in possible emergencies, oil is supplied by a special motor-driven pump mounted on the alternator base. When the alternator is working under normal operating conditions, a separate pump geared to the main driving shaft feeds the bearings, and the motor-driven pump is automaticaly cut out of service. The oil-supply tank is located in the base of the alternator, to which the oil returns after being pumped through the bearings. The oil gauge on the main feed pipe is fitted with a signaling circuit to call the attention of the operator in case the oil supply fails. The main bearings of the alternator, which are self-aligning, are also water-cooled by a series of copper pipes which run through the bearings near to the friction surface. The armatures of the alternator are also water-cooled from the same pumping source by a series of parallel copper tubes cemented in the frame alongside the laminations.

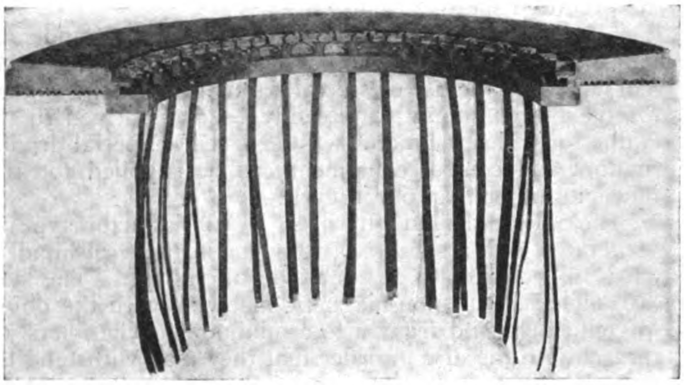


Figure 7—A section of the armature

In order to avoid large losses through magnetic leakage, the air gap between the rotor and the stator frame is maintained at a spacing of 1 millimeter. It is important that the rotor be kept accurately centered, for otherwise the armature coils on one side of the rotor will become overloaded. This is accomplished by the use of specially designed thrust bearings which are inter-connected by a set of equalizing levers with an adjustable controlling leaf between them. These prevent the possibility of binding between the thrusts, due to expansion of the shaft from heating, and they also take up automatically all slack in the bearings as they become worn. Any tendency towards a change in the air gap is thus counteracted by the action of the levers. The equalizers are in part, the heavy vertical column shown at the end of the alternator in figure 4. Should the air gap on either side tend to get smaller, the pull of the field on that side would cause an excessive strain on the thrust at the end and cause heating. This, however, is prevented by the leverage system, which automatically corrects this and holds the rotor in a central position at all times.

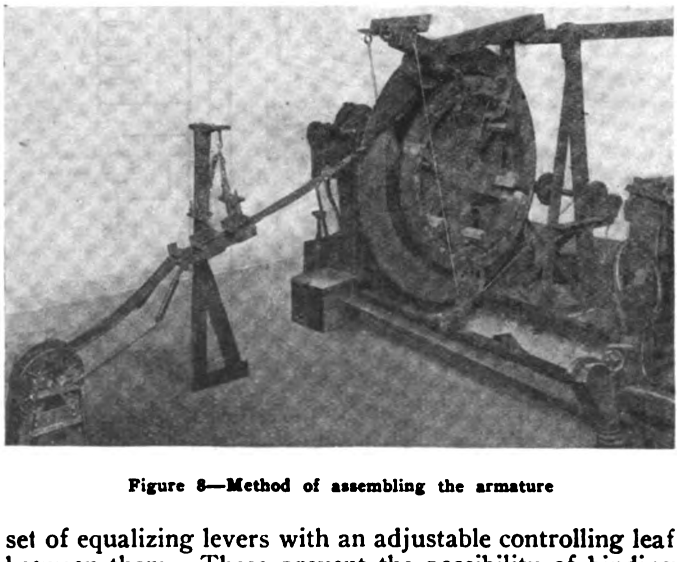


Figure 8—Method of assembling the armature

In regard to some of the electrical features of the alternator, it will be noted from figure 5 that the armature and field coils are stationary, the requisite flux variations for the generation of radio frequency currents being obtained from the slots cut in the rotor. The diagram points out the fundamental construction of the alternator and the general mode of winding the armature. The rotor disc revolves between the two faces of the field yokes. The direct current supplied to the field coils produces a magnetic field flux which passes between the field yoke faces and through the rotor as shown by the arrows.

The armature coils, which are placed in slots cut in the two faces of the field frames, are shown in the drawing as tipped away from the rotor, although in the actual machine the spacing between the rotor and the frame is but 1 millimeter. Two distinct armature windings are thus provided, one on each side of the rotor. There is but one conductor in each slot and two of these slots make a complete loop, and comprise a pole in the armature windings. One slot in the rotor is therefore provided for each loop in the winding. The armature windings on each side of the rotor are divided into thirty-two independent sections, the circuits of which are completed through transformer primary coils as shown in figure 5. Each primary consists of two turns with sixteen separate wires in each turn. There is no direct connection between the individual armature sections, but, through the two-turn primaries, they combine to act upon the secondary coils of the transformers. It is obvious that with this division of armature circuits the potential on any armature coil—or on the corresponding transformer primary—is very low, and as such, it permits a grounded or open-circuit armature coil to be cut out of the circuit and the operation of the alternator to be continued with but a slight decrease in its output—an obvious advantage.

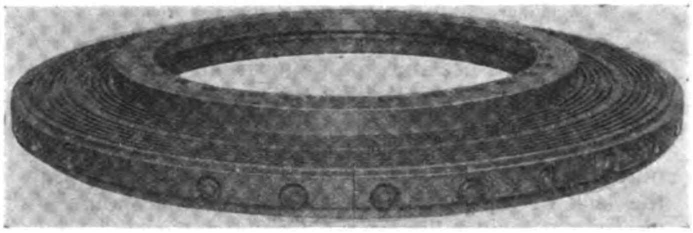


Figure 9—Completed armature ready for sawing into two sections

A detailed view of a portion of the alternator armature windings is given in figure 6, and of the preliminary stages of assembly in figure 7.

Figure 8 shows the laminated armature under assembly, which is wound with 0.037 millimeter steel ribbon and afterward machined into the shape of figure 9.

The completed rotor and its shaft appears in figure 10, while figure 11 is an end view of the alternator with the equalizing column removed. Figure 12 shows the alternator during one stage of the assembly—the driving motor, the alternator transformer and the thrust-bearing equalizing system not having been placed in position.

It is to be noted that a transformer is provided for the armature coils on either side of the rotor. There are therefore two transformers, and they each contain the three coils P_1, S_5, S_1 and P_2, S_5, S_2, shown in the fundamental station diagram figure 19. The primary of each transformer contains two turns of sixteen wires each, as mentioned above. The intermediate coils S_5 have twelve turns on each transformer. The two intermediate coils are connected in parallel, and are shunted by the magnetic amplifier. The coils S_5 are also connected in series with the secondary proper, and the antenna system.

The secondary coils, which consist of seventy-four turns on each transformer, are wound so that their high potential ends are at the center, in order to provide a uniform potential gradient. The two secondaries are connected in parallel and their final terminals are in series with the antenna circuit. More in detail, the low potential terminals of the intermediate coils are connected to the ground, the other terminals of the intermediate coils are connected to the low potential terminals of the secondary coils, and the high potential terminals of the secondary coils to the antenna loading coil. The intermediate coils S_8 are placed between the primary and secondary of each transformer in order to obtain a close coupling with the alternator. One unit of the high frequency transformer is shown in figure 13.

The voltage at the terminals of the secondary winding of the transformer when the alternator is operated at normal speed is about 2,000. The normal output current is 100 amperes. It is thus seen that the alternator is designed for a load resistance of 20 ohms.

Since the antenna circuit is directly associated with the alternator circuit, any change in the rotative speed of this machine would throw the alternator circuit out of resonance with the antenna circuit; consequently it is easily seen that the speed variation of a radio frequency alternator for substantially constant output must be held within very close limits. The variable load imposed by telegraphic signaling has a tendency to cause a variation of speed that must be compensated for by some device which operates more critically than any of the mechanical and electrical methods of speed control devised for ordinary power use. The characteristics of any satisfactory governor must be such that a small variation of speed will effect a maximum change in power input to the device under control. To accomplish this, some mechanism must come into such a critical state at the speed to be maintained, that a low percentage of change in speed causes a high percentage of change in itself.

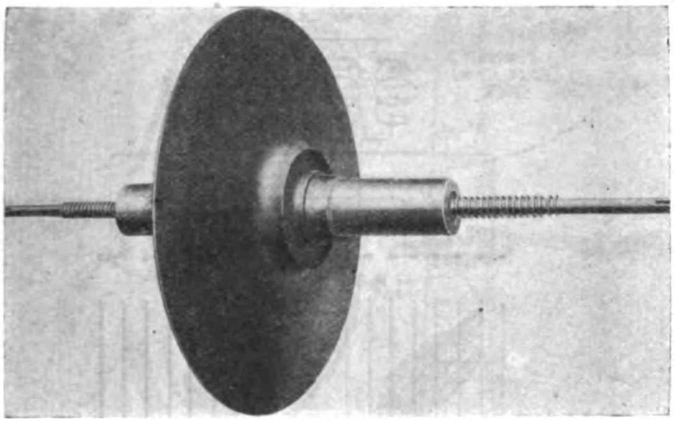


Figure 10—Typical rotor construction of the Alexanderson alternator

It can be shown that a change in speed of one-quarter of one per cent. from that necessary to maintain resonance will reduce the antenna current in a station utilizing the wave length of New Brunswick—13,600 meters—to one-half its full value. This clearly infers that the speed variation must be much less than one-fourth of one per cent. to maintain a constant output at the alternator. As a matter of fact, a regulation within one-tenth of one per cent. is obtained by the Alexanderson speed regulator.

The necessity for close speed regulation becomes equally important when considered from the standpoint of the receiving station. With a modern receiving apparatus of low decrement, a very slight change in the wave length of the incoming signal will materially decrease the received current. A change of wave length or frequency is likewise detrimental when reception is obtained by the heterodyne or beat principle, for should the speed of the alternator vary markedly while signaling, the beat note may vary to the degree that will render it objectionable for ear reception. A variation, for instance, of 50 cycles in the alternator will cause the beat note at the receiver to vary by 50 cycles, which is the equivalent of a speed variation of 0.23 per cent. at the wave length of 13,600 meters.

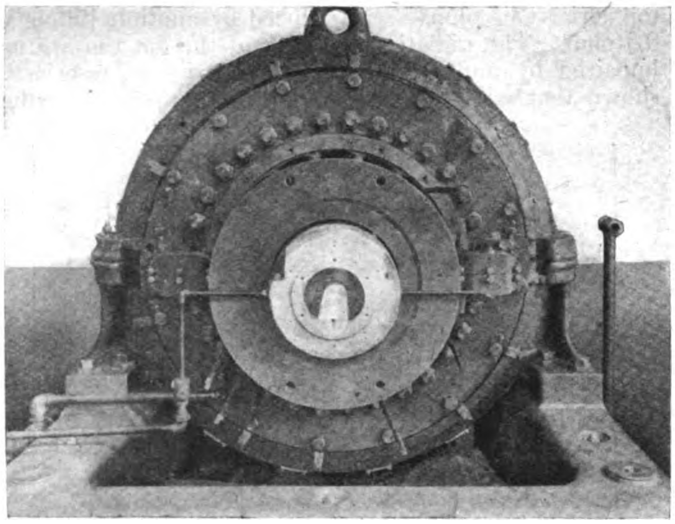


Figure 11—End view with air-gap equalizing mechanism removed

A solution of the problem of speed regulation with alternating current motor drive was found by Mr. Alexanderson in the use of a resonance circuit, which is tuned to a frequency slightly above the frequency to be maintained at the alternator. This circuit is supplied with current from one of the armature coils on the alternator. The current in this circuit increases with alternator speed and, through the agency of a rectifier, a direct current component operates on a voltage regulator connected in the circuit of the dynamo which supplies the saturation current for a set of variable impedances in the two phases of the motor supply circuit. The function of the regulator is to prevent, within established limits, either an increase or decrease of alternator speed. Additional compensation for the load imposed when signaling is provided by a relay which also operates through the direct current control circuits to vary the line impedances.

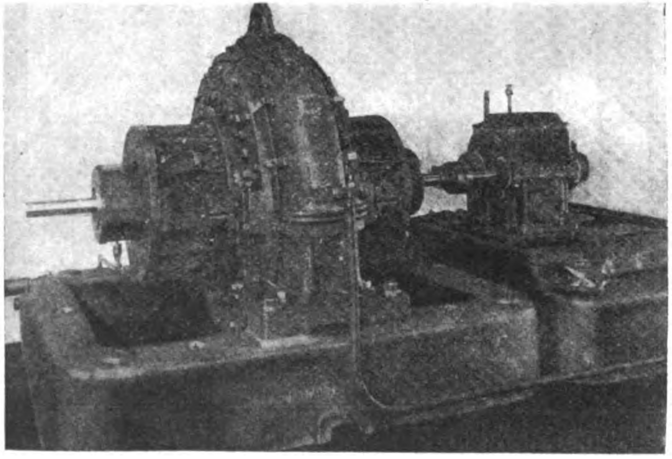


Figure 12—Alternator partially assembled

The panel board of the voltage regulator system is shown in figure 14.

The multiple tuned antenna may be said to establish a radical departure from the types of antennae formerly used for high-power radio transmission. The immediate object of the multiple antenna is to reduce the wasteful resistance of the long, low, flat-top aerials formerly used and to permit the length of such aerials to be increased indefinitely for the use of greater powers. In the case of the New Brunswick antenna, its resistance as a flat-top aerial—3.7 ohms—was reduced by multiple tuning to 0.5 ohm. The radiation qualities of the flat top are not impaired by multiple tuning, as a series of tests have shown that with an equal number of amperes in either types, the same signal audibility is obtained at a receiving station, but there is an enormous saving of power in the case of the multiple antenna, as will be presently pointed out.

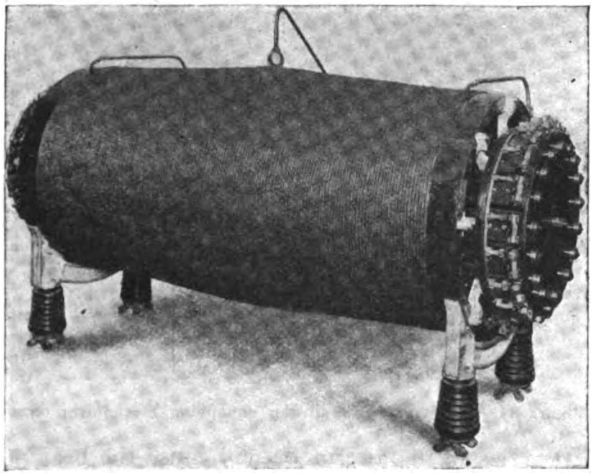


Figure 13—High frequency transformer

As shown in the station diagram, figure 19, the multiple antenna has, instead of the single ground wire usually employed, a number of ground leads which are brought down from the flat top at equally spaced intervals, and connected to earth through appropriate tuning coils.

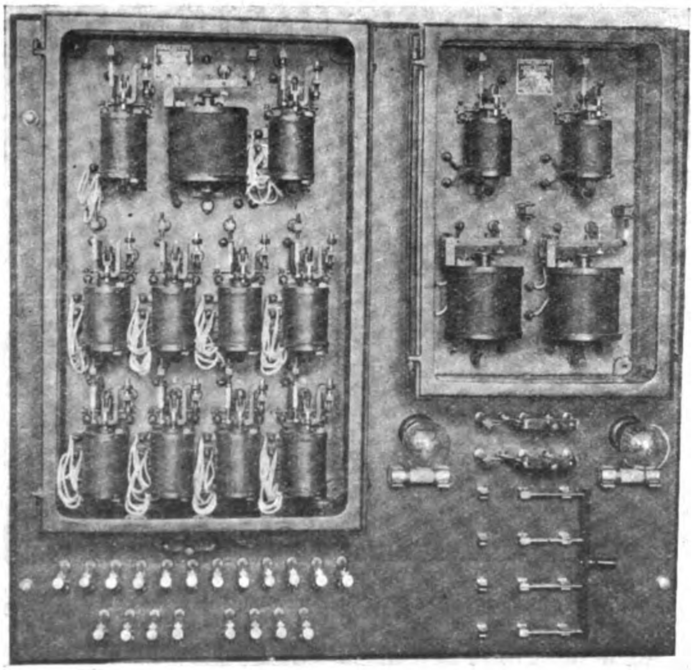


Figure 14—Control panel of current and voltage regulator

The capacitive reactance of the flat top is thus neutralized by inductive reactance at six points to earth, instead of but one point as in the ordinary system. The inductive reactance in each down lead is therefore made six times the capacitive reactance at a given frequency. The multiple antenna is thus the equivalent of six independent radiators, all in parallel and resonant to the same wave length. Their joint wasteful resistance obviously is much less than that of an antenna with a single ground, and herein lies the saving of power which the Alexanderson antenna brings about.

The relative power imputs required by both types of antennae for the same value of antenna current will be seen from the following illustration: To maintain 600 amperes in the multiple-tuned antenna at New Brunswick, at a resistance of ½ ohm, the power required is $600^2 \times 0.5$, or 180-k.w. To maintain the same antenna current in a flat-top antenna with resistance of 3.7 ohms requires $600^2 \times 3.7$, or 1330-k.w. The economy of power secured in the case of the multiple-tuned antenna is an important consideration from the standpoint of the cost of daily operation.

Prior to the advent of the Alexanderson antenna, theory and practice pointed to the desirability of a very high antenna structure for long distance communication at high powers, but as is well known, the cost of erecting an antenna increases very rapidly with the effective height. The multiple-tuned antenna, however, permits the use of a less expensive antenna structure, and gives the same signal audibility at a given receiving station as a high antenna of the old type with less power. The example given demonstrates quite conclusively that the multiple antenna will provide the same antenna current as the flat-top type antenna, but with only one-seventh of the power. The multiple-tuned antenna will be treated more comprehensively in a later article.

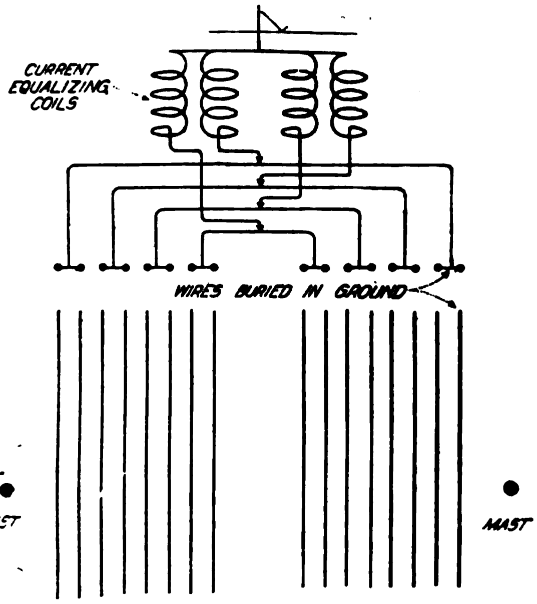


Figure 15—Schematic diagram of earth-wire system at the New Brunswick station

The earth-wire system at the New Brunswick station is a combination of a buried metallic and a capacitive ground. Sixteen parallel copper conductors are laid underneath the antenna and buried one foot in the ground. They extend the entire length of the antenna and are spaced between towers somewhat as shown in figure 15. A network of wires and zinc plates are also buried in the ground around the station. At each of the five tuning points outside the station, connection is made from the antenna flat top to the sixteen underground wires.

In order to secure equal distribution of current through the buried ground conductors, equalizing coils are inserted between the tap on the down lead coil and the earth wires at each of the five tuning points outside the station, as shown in detail, figure 15. The function of the equalizing coils is to increase the impedance of the wires near the center and hence force current in the outside wires. Since the coils are wound in opposite directions they add no appreciable inductive reactance to the tuning circuits. In one instance, the use of these coils reduced the multiple resistance of the antenna system from 0.9 to 0.7 ohm.

A still better distribution of the earth currents at New Brunswick was obtained by using a capacitive ground commonly known as a counterpoise, which is erected underneath the antenna and a few feet above the earth. A plan view of the counterpoise is shown in figure 16.

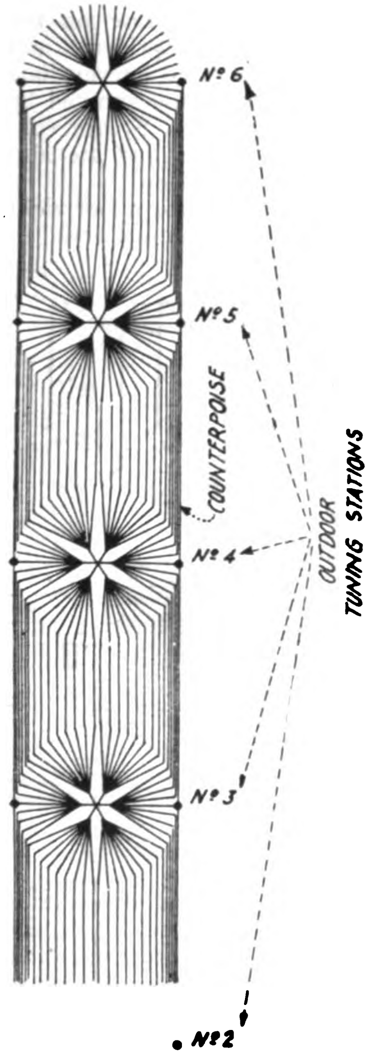


Figure 16—Plan view of counterpoise at New Brunswick Station

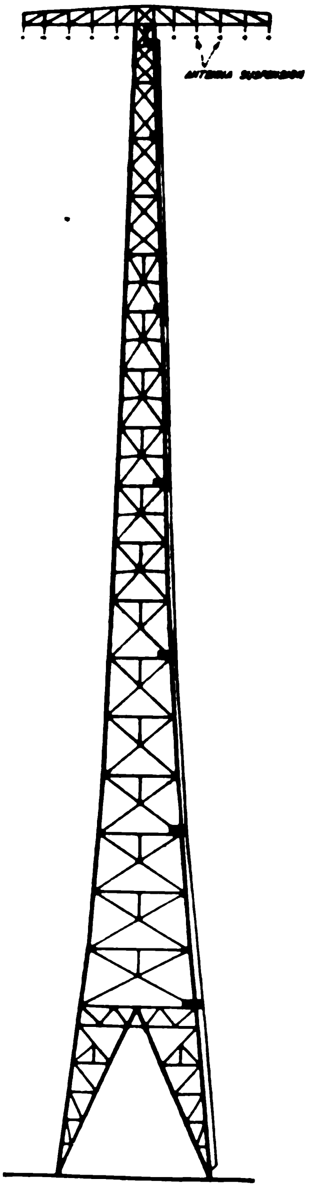


Figure 20—Design of standard tower used

The capacitive ground may be considered as a combination of a tuned and a forced oscillation circuit, and it has the effect of drawing the current from the ground circuit more uniformly than with wires lying on the ground or buried beneath the surface. In practice the total current in the down lead may be distributed betwen the capacitive ground and the wire ground in any desired ratio. The effect of adding this unit to the system at New Brunswick was to decrease the multiple antenna resistance from 0.7 to 0.5 ohm. The capacitive ground may be divided into separate units for each tuning down lead or the units may be connected together as shown. A schematic diagram of the connections between the flat top and the capacitive and earth-wire grounds is shown in figure 16a. The equivalent circuit is given at the right of the drawing. The construction of the outdoor inductances for multiple tuning is shown in figure 17.

Telegraphic control of the large antenna currents involved in high-power radio transmitters has ever presented a difficult problem. Particularly has this been true when signaling at high speeds. Rapid signaling obviously requires some device that will not cause destructive arcs and will provide the desired modulation of antenna power without taking upon itself the burden of carrying the full power of the system, during the intervals between signaling.

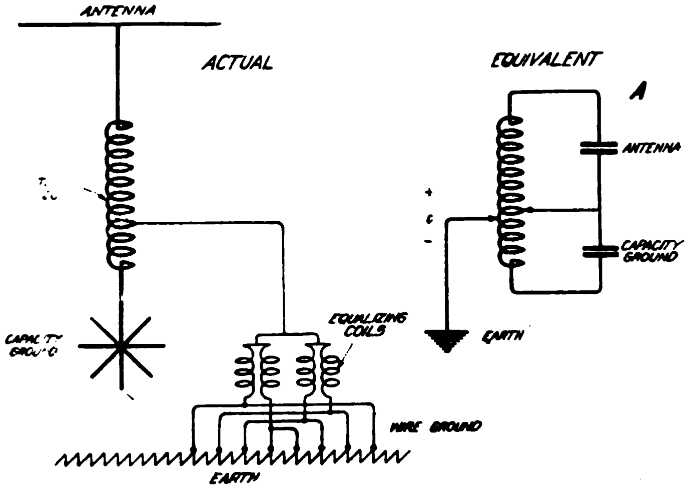


Figure 16A—Schematic diagram of antenna to earth connections of the multiple tuned antenna

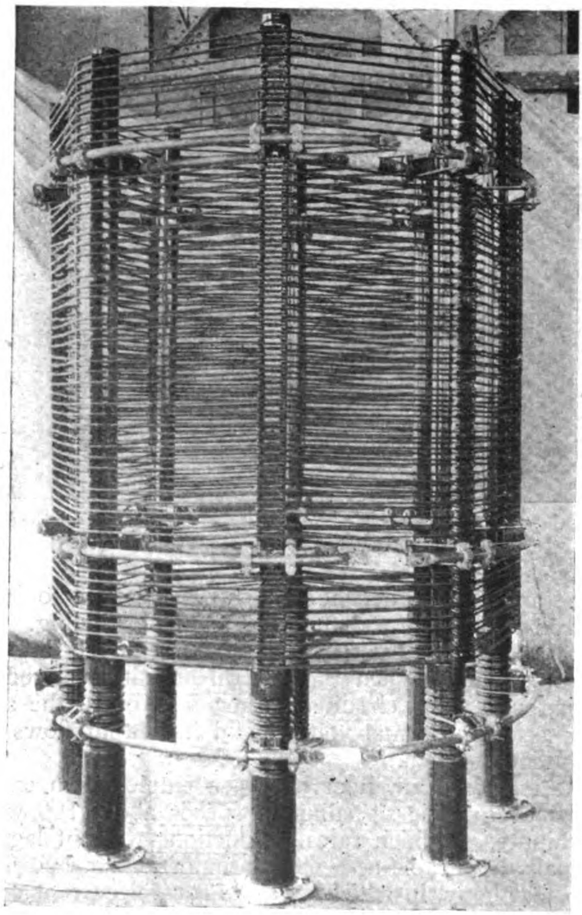


Figure 17—Tuning inductance for multiple tuned antenna

The magnetic amplifier is a device which meets these exacting requirements, for it provides a non-arcing control with a minimum current in the key circuit, and it takes within itself only a small proportion of the total alternator output. A photograph of the amplifier, removed from its container, is shown in figure 18.

The magnetic amplifier in general may be described as a variable impedance which is connected in shunt with the external circuit of the radio frequency alternator. Its function is to reduce the voltage of the alternator and to detune the antenna system when the sending key proper is open, and to perform the opposite functions when it is closed. Thus when the sending key is open the amplifier short-circuits the alternator and detunes the antenna system, thereby reducing the antenna current to a negligible figure. When it is closed the output of the alternator is fed to the antenna system.

A general idea of the operation of the amplifier can be obtained from the fundamental circuit, figure 19, where it will be noted that the radio frequency coils A and a control coil B are mounted on a common iron structure, and are so disposed that the effect of the control coil upon the radio frequency coils is obtained solely through the agency of flux variations within the core. The impedance of the amplifier is dependent upon the degree to which the iron core is saturated by the control winding. The saturation in turn varies as the current fed into the control circuit. When the control circuit is closed the alternator is short circuited; when it is open, the alternator assumes normal voltage and its output flows into the antenna system.

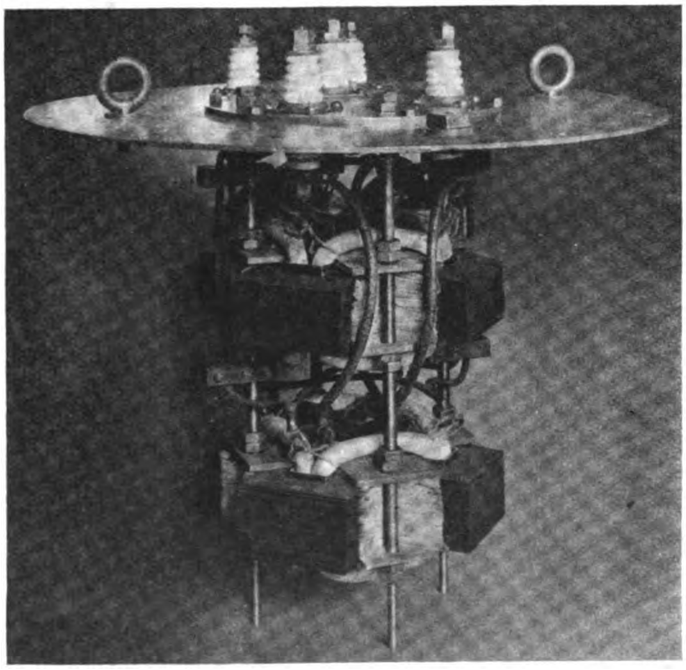


Figure 18—Magnetic amplifier removed from case

The magnetic amplifier has been employed in experimental telegraphic signaling at speeds above 500 words per minute, at which rates it functions without lag. It is equally applicable as a modulator of antenna power in radio telephony, in which case the control current of the amplifier is modulated at speech frequencies by a bank of Pliotron (vacuum tube) amplifiers, which in turn are controlled by an ordinary speech microphone.

The characteristics of the amplifier will be treated in greater detail in a later article.

The fundamental circuits of a typical Alexanderson alternator station are shown in figure 19. Beginning at the left of the drawing, it is to be noted that a source of two-phase, 60-cycle alternating current drives an induction motor M, having a wound rotor, the circuits of which include a liquid rheostat R_3. The motor is connected to the radio frequency alternator through a helical step-up gear.

The alternator armature coils are indicated at A_3, A_4, the field coils at F_1, and the rotor at A_2. There are two sets of armature coils one on each side of the rotor, which as already mentioned, are divided into 32 sections on each side. The windings on each side connect to the primaries of two transformers shown at P_1, P_2. The primary of each transformer (see figure 5) contains two complete turns of 16 wires in each turn, which carry the current developed in the 32 sections of the armature coils on each side of the rotor. As can be seen from the diagram, there is no direct electrical connection between the armature circuits leading to the transformer primary, but the individual primary circuits are disposed so that their magnetic fields at any instant are in the same direction; that is, their fields combine to operate on the secondaries S_1, S_2. In addition to the primary and secondary coils, the two transformers have intermediate coils S_5 which are connected in parallel and shunted by the magnetic amplifier coils A. The coils S_5 are connected in series with the antenna system, and are also closely coupled to the primary and secondary.

The multiple tuned antenna, shown in the upper right hand part of figure 19, is a long, low, horizontal aerial of the Marconi type, from which are brought down leads to earth, which include the tuning inductances L_1, L_2, L_3, L_4, L_5, L_6. For any given wave length the joint inductive reactance of the down lead circuits $L_1 \ldots L_6$ is made equal to the capacitive reactance of the entire flat top at the operating frequency or wave length. The multiple antenna is therefore the equivalent of six independent radiating systems resonant to the same wave length, and for all practical purposes, the oscillating currents in them flow in phase.

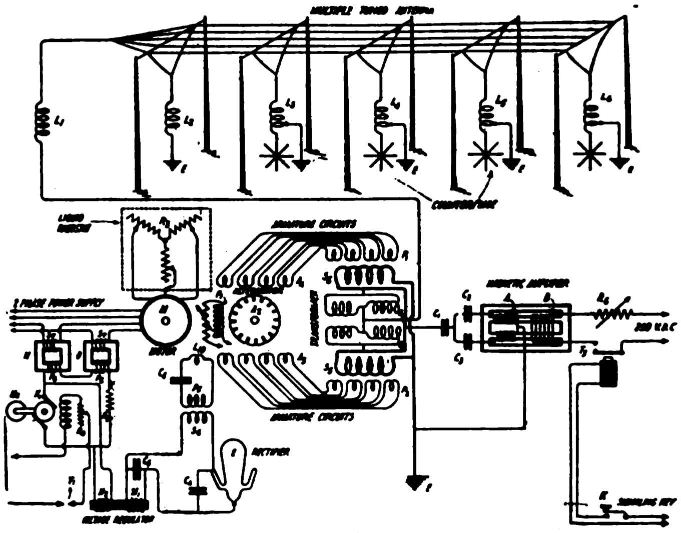


Figure 19—Fundamental station diagram

The magnetic amplifier, shown to the right of the diagram, comprises the parallel-connected impedance coils A, which are connected in series with the condenser C_1 and the transformer amplifier coils S_5. B is the control coil, wound to include both branches of the windings A, which is fed with direct current, regulated by the rheostat R_6. When the control circuit is closed the impedance of the amplifier coils A become a minimum; when it is open the impedance is a maximum. In the former case the alternator is placed on short circuit and the antenna is detuned; in the latter case the alternator assumes normal voltage and its output flows into the antenna system. In practice the capacity of C_1 is selected to neutralize the inductance of windings A for some value of current in the control coil.

The circuits of the speed regulator appear in the lower left hand part of the drawing. Note is to be made first of the variable impedances N and O in the motor supply line with their direct current control coils P_6 and the variable impedance coils S_7.

The extremely close speed regulation essential to alternator operation is obtained from the resonance circuit L_{10}, C_4, P_5, the coil L_{10} being one of the alternator armature coils. This circuit is made resonant to a frequency slightly above the normal frequency at which the alternator is to be operated and the current developed therein acts inductively on the circuit S_6, E, M_1—E being a rectifier. The latter rectifies the radio frequency current and sends a D. C. component through M_1, which acts with an increase of speed to decrease the voltage held by the voltage regulator M_2 T_1 on the generator K_1. This increases the impedance of the coils S_7 and therefore tends to reduce the speed of the driving motor. As the speed now falls the current in the resonant circuit falls off and likewise that in the coil M_1. This permits the voltage held by the voltage regulator to increase, and therefore acts to reduce the motor supply line impedance and thus increase the speed. A given mean voltage is thus maintained in the control circuit by generator K_1, which depends upon the magnitude of the control current in M_1. This keeps the speed variation within exceedingly close limits.

The trend of future development is of interest. In event that a larger output than that provided by a single alternator, of 200-k.w. is desired, parallel operation is contemplated. Such operation is entirely practicable and will be employed in the Radio Corporation's high-power stations, when great distances are to be covered.

A standard tower for high-power stations is shown in figure 20. This is of the self-supporting type erected on a suitable concrete base. The antenna wires are suspended from the steel cross arm at the top. This method of antenna suspension lends itself admirably to the long narrow antenna which has been found most suitable for the Alexanderson system.

The antenna layout for a two-alternator unit high-power station using these towers is shown in figure 21, where two antenna wings of any desired length extend in opposite directions from the station house which is located at the center. With this construction the wings may be tuned to different wave lengths and each energized by a single alternator, thus permiting simultaneous transmission at two different wave lengths; or the two alternators may be joined in parallel to energize both wings at some selected wave length.

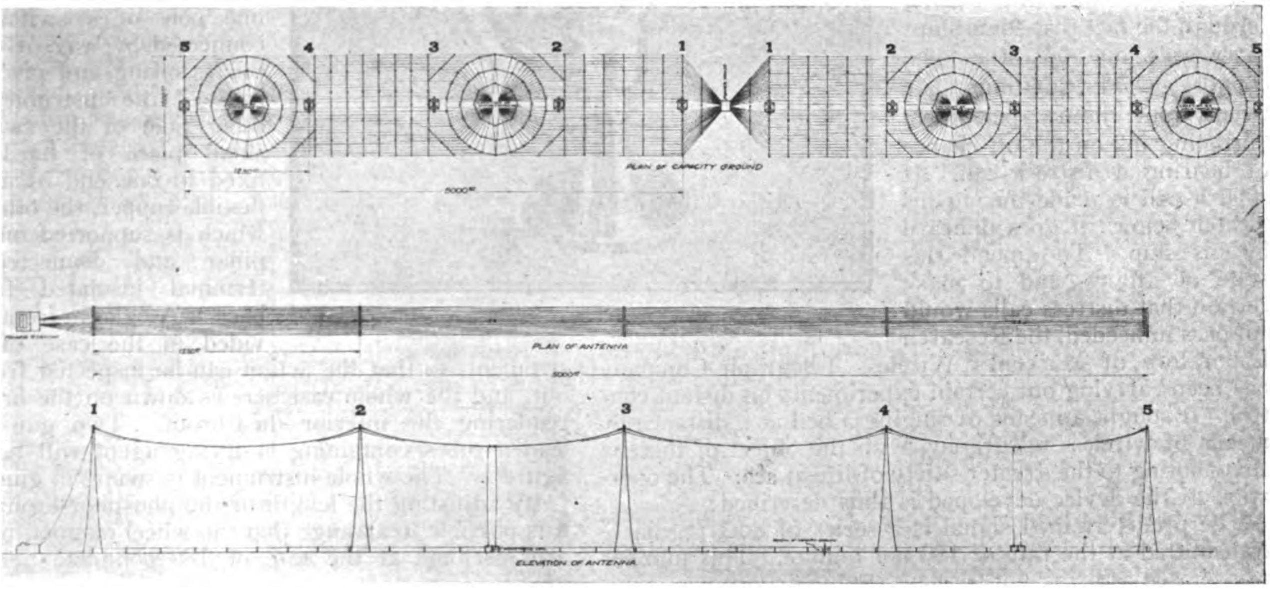


Figure 21—Typical antenna and counterpoise construction

Performance and Operation
of the
New Brunswick Station

and the Alexanderson System will be described in detail in the August issue.

The New Marconi Distress Calling Device

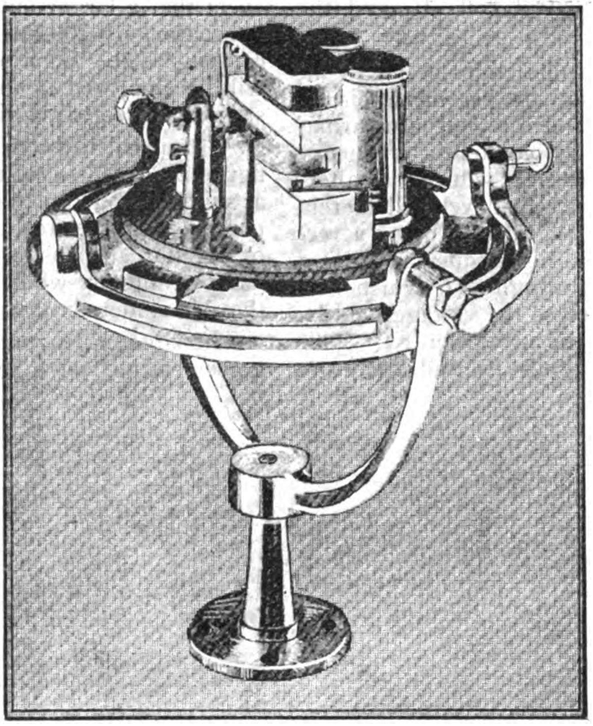


Figure 1—Final design of the Marconi distress calling device

IN THE February issue announcement was made of a demonstration conducted in England between Chelmsford and Shelford (Cambridge), in which the station at Shelford rang an ordinary electric bell and exploded small mines at Chelmsford, by means of special wireless signals. The purpose of the tests and a description of the apparatus are now available.

A recent article in "The Wireless World" directs attention to the problem arising through the fact that some ships carry only one operator, who cannot spend anything like twenty-four hours per diem "listening in" on the off-chance of hearing a distress call. If such a call is made during his "watch below" it goes unheard by his ship. To amend this state of affairs, and to make certain that distress calls would not pass unheeded, the Research Laboratory of Marconi's Wireless Telegraph Company has been carrying out certain experiments on distant control. It sought a means of ringing a bell at a distance by means of wireless telegraphy, with the object of thereby contributing to the greater safety of life at sea. The operation of the device developed is thus described:

The predetermined signal is a series of dots regularly transmitted at the rate of 180 per minute. This number was chosen as being not too fast for the operator to count and time, and too slow to be interfered with by ordinary transmissions.

The first thing was to make a relay which would respond only to the predetermined signal, and which could be operated by the change in current produced by the reception of such a signal. The change in current with the vacuum tubes in use in the receiver was never more than half a milliampere.

Many relays were made, and tried out, and for various reasons were rejected. The final design is shown in figure 1, and in construction is not unlike the ordinary moving needle galvanometer. In brief the description is as follows: Two rectangular hollow forms each wound with many hundreds of turns of very fine wire are placed one above the other on a brass base, the windings being connected in series, and the free ends being taken to two insulated terminals in the base. In the rectangular orifice of the coils swings a small ring magnet, pivoted at its centre and supported in jewelled bearings which are carried by two vertical brass pillars screwed to the base. The pivot also carries a small circular phosphor-bronze spring, one end of which is attached to a brass collet on the pivot, the other end being soldered to a tongued brass washer clamped to one of the brass pillars. This tongued washer serves the same purpose as the zero adjustment on an indicating instrument. By twisting it about its center the position of the magnet can be altered and the best working position obtained. Besides these two details the pivot has fixed at right angles to itself a fine platinum-tipped steel arm. This arm is one pole of a switch and is connected by way of the brass pillar, spring and pivot, to the base of the instrument. The other pole of the switch is a small piece of hard carbon, fixed to one end of a strip of flexible copper, the other end of which is supported on a small pillar and connected to a terminal insulated from the base. A glass front is provided in the case of the instrument, so that the action can be inspected from without, and the whole case screws down on the brass base, rendering the interior dust-proof. Two gauze-capped leaden tubes containing a drying agent will be seen in figure 1. The whole instrument is swung in gimbals.

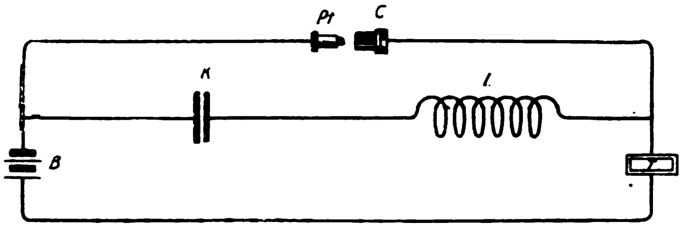


Figure 2—Circuit showing the modified connections

By adjusting the length of the phosphor-bronze spring it is possible to arrange that the wheel magnet, pivot, and arm oscillate at the rate of 180 complete periods per minute.

The resistance of the coils and the current available are sufficient to prevent a single dash, or series of mixed dots and dashes, such as are received in an ordinary telegraphic communication from swinging the moving system far enough to cause the two contacts of the tiny switch to touch. It is only by the regularly delivered impulses arriving at the right moment that the swing can be built up from zero to full, and contact established.

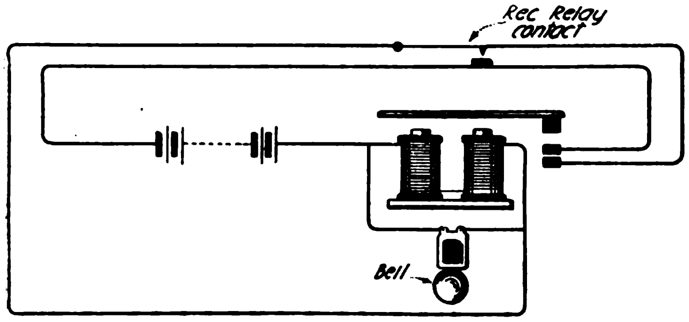


Figure 4—Circuit of instrument that operates alarm circuit

Some trouble was experienced with this tiny switch. In the original model both contacts were made of platinum and sometimes they did not strike with sufficient force to make good contact at the first time. To overcome this fault Dr. Fleming's Patent No. 112544 of 1918 was employed. The modified connections of this patent are as shown in figure 2. In figure 2, Pt is a contact of platinum or other noble metal, C is a hard carbon contact, K a condenser, L an inductance, T an instrument which it is desired to operate by the battery B on closing the switch Pt C. The battery charges the condenser, and when the switch closes the condenser discharges through the inductance and oscillations pass across the points Pt C and improves the contact at those points.

The point next to be considered was an arrangement for permanently closing the alarm circuit once the contact had been struck, and the instrument shown in figure 3 was designed.

This instrument consists of two coils with soft iron cores mounted on a soft iron plate, forming an electromagnet. Above these coils is placed a soft iron armature connected with a flat steel spring at one end to a brass standard, the other end being free. At the free end is carried a small insulator, which, when the electromagnet is energized, will depress a short platinum-tipped steel spring on to a similar one; also at a little distance from the free end is fixed a manipulating key contact which can strike a similar one situated immediately beneath it.

The action is as follows: The platinum-carbon switch of the receiving relay is connected in series with a 24-volt battery and the coils of this electromagnet; the two platinum-tipped steel springs are connected in parallel with the platinum-carbon switch. When this switch makes contact the electromagnet is energized and the armature is drawn down and closes the switch formed by the two steel springs. This switch being closed and in parallel with the first switch the magnet will remain energized, and the armature depressed, until the battery is switched off. Figure 4 shows these connections. Neglecting the resistance of the connections, it will be seen that as long as the electromagnet is energized there will be a P.D. of about 24 volts at its terminals. The alarm bell, which is an ordinary high-power bell working off 24 volts is connected in parallel with the electromagnet, and so long as the latter is energized the bell will ring.

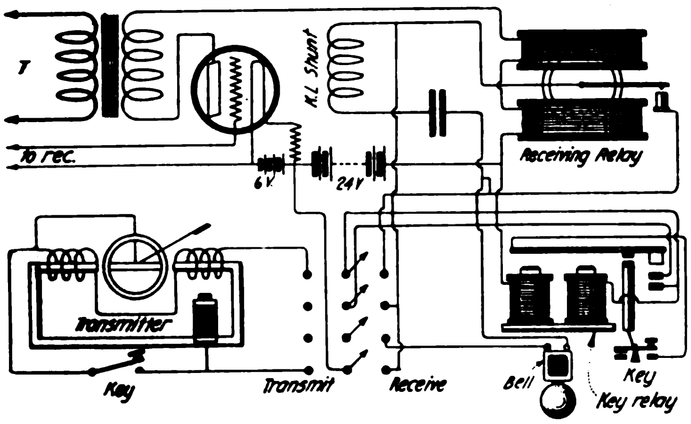


Figure 6—Complete diagram of connections from the receiver to manipulating key

The adopted automatic transmitter is as shown in figure 5. The instrument consists of two iron-cored coils mounted on a yoke, the whole forming an electromagnet. Between the poles of this magnet swings a heavy brass ring with a soft iron diametric bar. To the shaft carrying the ring are attached a spiral steel spring, like a clock spring, and a light flexible steel arm tipped with platinum. Below this arm is a small platinum contact, supported by a helical spring contained in a tube. The free end of the clock spring is clamped to a projection on the wheel of a worm gear, and a handle is provided on the screw of this gear, so that the distance of travel between the moving contact on the shaft, and the spring-supported contact, can be varied. The variation of this travel controls the period of the transmitter, and it is found that the shorter the travel the shorter the period. Three terminals are brought through the base and the whole instrument is mounted in gimbals.

For transmission, a series circuit is made comprising a 24-volt battery, the coils and contacts of the transmitter, and the coils of the instrument shown in figure 3; a small tapping key is connected in parallel with the transmitter contacts. To start the instrument this key is pressed and immediately released. By thus closing the circuit the electromagnets of both instruments are energized and the iron bar of the wheel swings towards the magnet. The circuit being broken and the magnet demagnetised the wheel is urged by the clock spring past its position of rest, and on until the contacts of the transmitter touch; attraction starts again and the circuit is again broken, and so the cycle of events is repeated as long as the battery is switched on. Each time the wheel transmitter is energized the electromagnet shown in figure 3 is energized, the armature is drawn down, and the heavy key contacts meet. These contacts are in parallel with those of the manipulating key of the ship set, so provided that the generator is running, sparking occurs at every striking of the contacts. By means of a watch and the worm gear previously referred to, the operator can adjust the frequency of his signal to a nicety, and when once this is adjusted it is unlikely to vary.

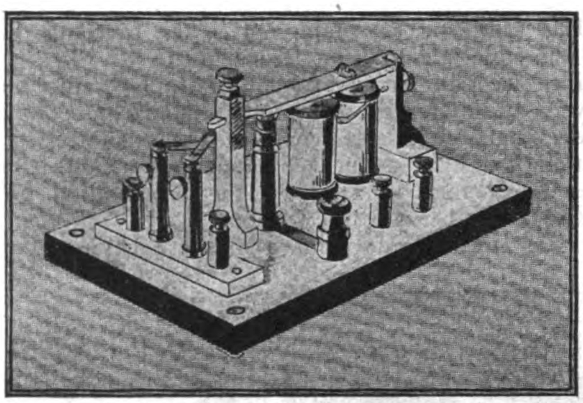


Figure 3—Instrument for permanently closing the alarm circuit

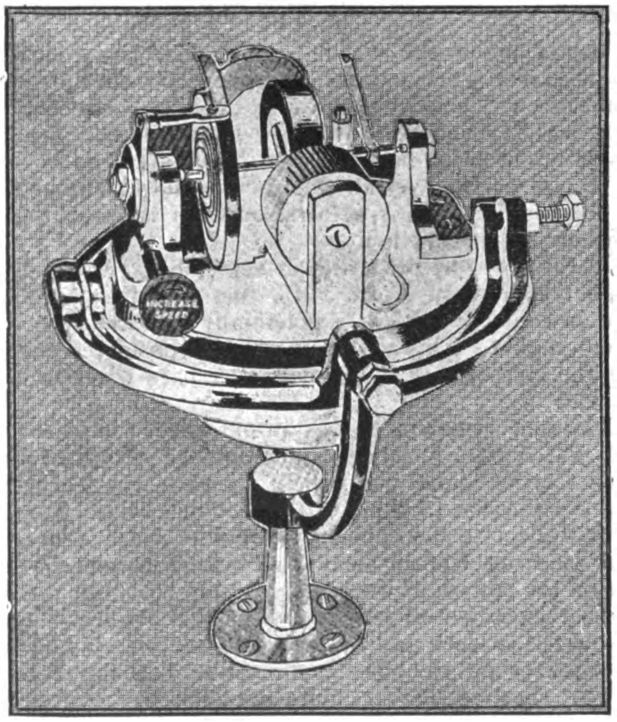


Figure 5—The automatic transmitter

Figure 6 shows the complete diagram of connections from the last vacuum tube of the receiver to the contacts of the manipulating key.

Transmission of High Frequency Waves Over Bare Wires in Water

By Major General George O. Squier

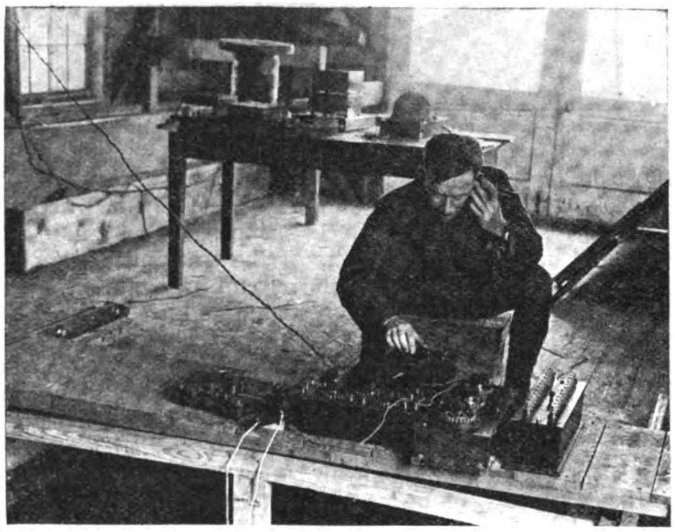
Chief Signal Officer, United States Army

(Abstract of a paper presented to the National Academy of Sciences)

THE following reasoning led to the carrying out of the experiments to be described:

Since we can already communicate by radio means between one submarine and another submarine, both completely submerged, it was considered that connecting two such stations by a submerged copper wire could have no other effect than to facilitate the propagation of the electric waves between the stations.

It was considered possible that the behavior of earth or water under the action of high frequency currents might exhibit greatly different properties from those with which we are familiar at direct or low frequency currents.



Receiving apparatus used in telephoning and telegraphing by means of bare wire laid in water

It was realized that whatever high frequency energy losses might occur in the case of bare wires laid in earth or water, yet the over-all efficiency would be higher than in the case of radio space transmission where the plant efficiency is so very low.

It was noted by the writer in September, 1910, and discussed by him in April, 1912, that the three electrode audion could be used as a potentially operated device on open circuits. This arrangement was considered suitable for the reception of the signals over bare wires in earth or water.

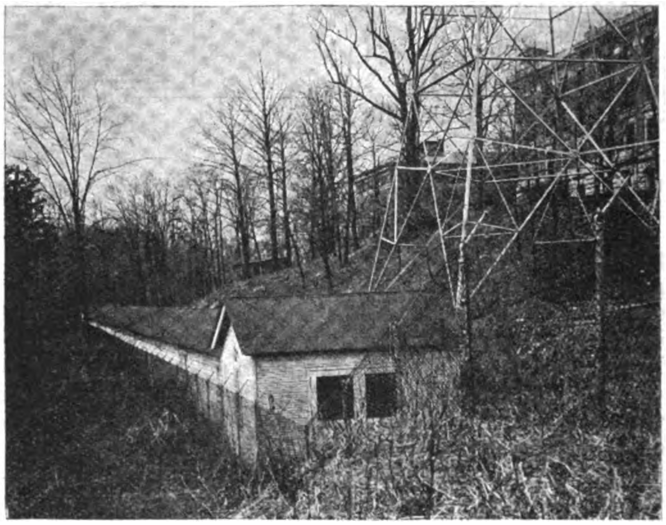
The first experiement was an extremely simple one as follows: A bare No. 18 phosphor bronze wire, such as is used for the Signal Corps field antenna, was laid across the Washington Channel of the Potomac River from the War College to the opposite shore in Potomac Park. It was paid out from a small boat with sufficient slack to lay on the bottom of the river. A standard Signal Corps radio telephone and telegraph set, SCR 76, was directly connected to each end of the wire, one set serving as a transmitter and the other as a receiver. At the receiving end of the line the bare wire was directly connected to the grid of the receiving set and the usual ground connection left open. A frequency of about 600,000 cycles a second was used and the line tuned at each end by the usual methods. Excellent telegraphy and telephony were obtained. Care was taken to make this preliminary experiment as simple and basic as possible and precaution taken to insure that the wire itself should be bright and clean and entirely free from any grease or other insulating material.

The success of this simple experiment immediately led to more thorough consideration of the entire subject.

One of the questions to be investigated was the general efficiency of the electron tube when used as a potentially operated instrument. The following experiment was made:

A strip of wire netting was buried in the snow outside the office of the Chief Signal Officer in Washington and a wire attached thereto leading to the second story of the building. The upper end of this wire was connected directly to the grid of an electron tube. The reason for connecting the grid to the upper end of the antenna is of course obvious if we are to use the tube as a potentially operated device. It was necessary for maximum sensitiveness to connect it to the point of maximum potential of the antenna which in the case of a linear oscillator occurs at the open end. By this arrangement, messages were readily received from distant points in the United States.

These two simple experiments demonstrated the possibility of transmitting electromagnetic waves along bare wires submerged in water and the use of an electron tube as a potentially operated device for the reception of signals.



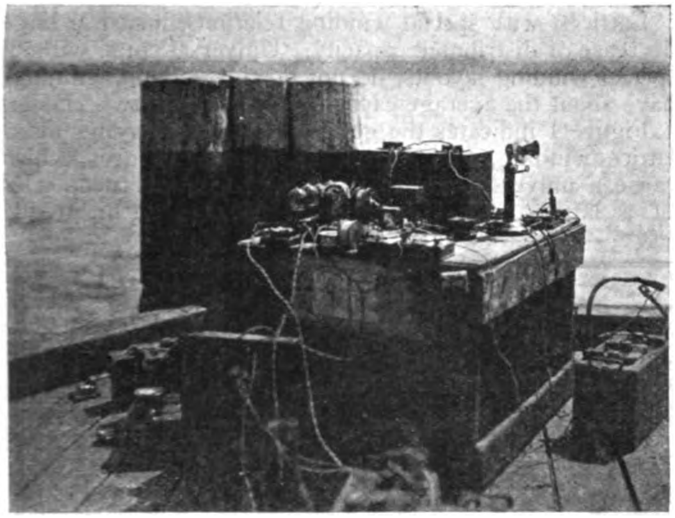
Exterior view of the U. S. Gov. research laboratory where experiments were carried out

For military reasons, if for no other, the Signal Corps has recently undertaken certain investigations in the phenomena connected with the transmission of high frequency electromagnetic waves over bare wires in earth and in water.

In carrying out these investigations and in attacking the problems from various angles, the research staff of the Signal Corps laboratory at Camp Alfred Vail, Little Silver, New Jersey, was directed to carry out experiments on bare wires laid on the surface of moist ground and also buried in earth. The staff at the Signal Corps research laboratory at the Bureau of Standards was directed to investigate fundamentally the transmission of electromagnetic waves over bare wires in fresh water. In addition to this, the engineering staff of the Office of the Chief

Signal Officer has carried out from time to time certain experiments of a more or less crucial character which have come up for solution in the prosecution of this work at the other laboratories.

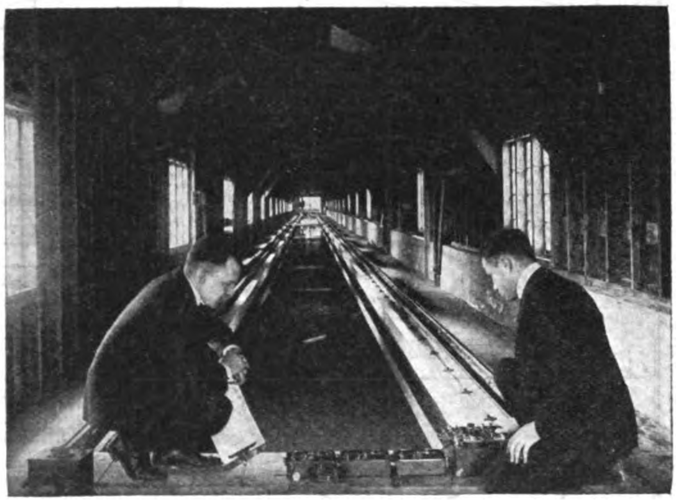
Telephone and telegraph communication has been established between Fort Washington, Maryland, and Fort Hunt, Virginia, across the Potomac River, below the City of Washington, over a distance of about three-quarters of a mile, by the use of a bare No. 12 phosphor bronze wire laid in the water to connect the stations. The transmitter consisted of an electron tube oscillator which delivered a current of about 270 milliamperes to the line at a frequency of about 600,000 cycles a second. At the receiving end of the line an electron tube and a 6-stage amplifier were used without any ground connection. With this arrangement good tuning was obtaied at both ends of the line, and telegraphic and telephonic transmission secured over the bare wires immersed in fresh water.



The transmitting apparatus containing an electron tube oscillator

A resonance wave coil has been developed. The coil is in the form of a long helix wound with a large number of turns on which stationary waves are produced by the incoming radio signals. An electron tube is used as the detector, the grid being connected to the point of maximum potential on the coil. The wave coil may be used either as a part of the usual antenna system or a part of a line wire, or it may act itself as the antenna for picking up the energy of the signals. In the latter case the coil may be either free at both ends or grounded at one end. Good results have been obtained in either case. It has been also found that the open coil has directional properties and can be used as a goniometer not only for horizontal measurements but for vertical measurements as well. This form of radio goniometer has the great advantage that it permits not only of determining the plane where the signals are strongest but also the direction from which such signals proceed.

Telegraph and telephone communication has been also established between two stations at the Signal Corps Research Laboratories at Camp Alfred Vail, Little Silver, New Jersey, using a bare No. 16 copper wire buried in the earth to a depth of about eight inches to connect the stations. The distance between the two stations was three-quarters of a mile. Frequencies as high as one million cycles a second were used. Similar communication has been carried on over a bare wire one and three-quarter miles long laid on the surface of moist earth. The current at the transmitting station in these installations was about 100 milliamperes. It has been shown that a bare wire buried in moist earth with the distant end open can be tuned both at the transmitting end and at the receiving end.



Members of the engineering staff at the research laboratory observing the effects of the transmission of electro-magnetic waves over bare wires laid in fresh water

The development of types of resonance wave coils, both open at one end and at both ends, for general radio work offers an interesting field for investigation. This involves the study of the electron tube as a potentially operated device. The application of such coils properly designed for specific purposes may lead to the practical solution of a number of radio problems such as directional effects, and wave coils antennae of very small dimensions.

IN THE AUGUST WIRELESS AGE

Second instalment of "WII—New Brunswick" containing a description of the performance and operation of the Alexanderson system.

An Impedance Curio.

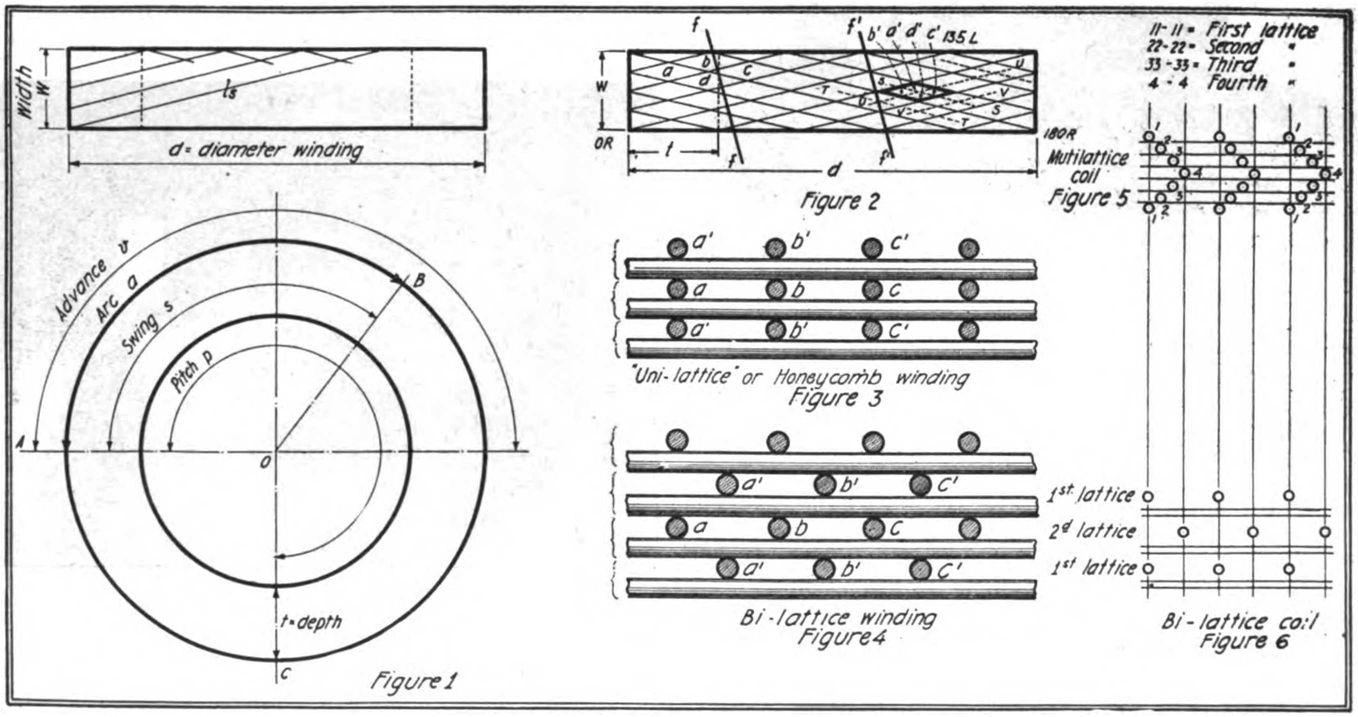
Operating suggestions for the radio amateur.

Universal, Honeycomb and Lattice Coils In General

By Oscar C. Roos
Fellow I. R. E.

THE sudden wide adoption of the universal winding by radio engineers as standard for inductances, has produced conflict and confusion in the names used in the trade to designate various makes. Technical facts have been ignored in the emphasis laid on "selling points."

There are the following names in use to denote varieties of universally wound coils—"Honeycomb," "unilateral," "duo-lateral," "uni-lattice," "mono-lattice," "bi-lattice," and "multi-lattice." Why all these "names?" Are they necessary? Cannot engineers adopt a "non-partisan" classification of the universally wound coils which are really different in winding layout and electrical properties?



Figures 1 to 6—Details showing method of laying out winding and views at various stages of the winding

This paper is an attempt to "clear the air." It touches the subject quite fully on the winding and general properties of universal coils. It adopts the terms, "uni-lattice" for "honeycomb" coil, and "bi-lattice" for "duo-lateral" coil. They are both different from "multi-lattice" coils.

These technical names have an advantage over trade names in that they prevent the physical properties of the different forms from being confused. This has prevented, in several investigations, a great deal of misunderstanding, regarding the differences in their winding schemes.

The following definitions have been tried out by several engineers and have run the gauntlet of general discussion.

All coils wound after the methods used in the machines of the Coto Coil Co. are "universal wound." The average experimenter will not produce a real "honey comb" coil, and still less, a "bi-lattice" coil (these are defined below) by just sticking on a coil frame and winding it up "bobbin-fashion," the way our mothers used to do their sewing machine bobbins. The very thing the experimenter wants—low capacity—will not be obtained to any extent, even at the cost of the extra wire which is needed in all universal windings to obtain a given inductance.

Lattices, with special winding relations, insure a large decrease of distributed capacity. Universal coils, without special winding layouts, do not do this. Bank windings have about the average capacity of the above two classes.

Figure 1 indicates the general method of laying out a lattice winding, and shows the special features which cause a universal coil to have the additional properties of a lattice coil. The general features in figure 1, peculiar to a merely universally wound coil are—first, the "angular swing, S," or simply the "swing" of the wire. This is the angle AOB between the elements of the cylinder, between which the "swing" takes place. Second—the length of the swing or the "linear swing, ls" is the actual length of wire in the swing. Third, the "swing arc" or the "arc," which is the length of the arc denoted by the letter "a." Fourth—the "angular pitch" or the "pitch" which is always twice the swing, e.g. the swing in figure 1 is 135 degrees, and the pitch is therefore 270 degrees. Fifth—the "advance, v," which is the angular distance which some multiple of the pitch first reaches, beyond 360 degrees. The advance in figure 1 is 180 degrees, or the difference between twice 270 degrees and 360 degrees. Sixth—a sparation of wire of h inches. Now the lattice has two additional features, an advance which is an exact submultiple of the pitch and 360 degrees also and a width such that, if m is the above submultiple, the width of the coil w, is $\frac{hm}{2}$ if m is even and $\frac{h(m+1)}{2}$ if m is odd. Hence figure 1 does not represent a lattice coil, strictly speaking.

A swing of 82 2/7 degrees, or other odd fraction of a degree is the kind of swing necessary to get a true lattice, in actual computations. A good short rule is this. The advance must divide 360, and the pitch also. If we adopt 1.5 degrees as the advance v = 1.5, we can get along with a pitch of 183 degrees, 186 degrees, etc., since 1.5 goes into 183 degrees, 186 degrees, etc., and 360 degrees exactly.

We now define lattice coils as those universal coils in which the advance is a submultiple of the circumference and the swing. This is limited only by the condition that the advance must be less than one-half the pitch.

The result of this definition is that all lattice coils end at the same angular point on the circumference at which they start. There is no "creeping" forward of the turns, "stopping up" the radial view through the cells and increasing coil capacity. When the lattice winding has come back to the starting point just once, we have one "layer." This gives us the pattern of a rhombus, or lozenge, which resembles a honeycomb cell and suggested the trade name used by many.

All honeycomb coils are lattice coils, but all lattice coils are not honeycomb coils. The bi-lattice coil described below is not a honeycomb coil, but a uni-lattice coil is.

Figure 2 is a lattice coil of external diameter a, and width w. It shows the honeycomb structure at the left and illustrates the "bi-lattice" differences in structure at the right. If we had repeated the first single "layer" of the lattice winding above specified, until a depth t, was reached, we could look down into the four "cells," a, b, c, and d in figure 2, without finding anything to obstruct the vision. The wires forming the walls of the cells are arranged substantially one over the other. They spread slightly as they recede radially from the axis of the coil.

The bi-lattice coil is so wound that every cell of the original four, a, b, c and d, is broken up into four smaller cells a′, b′, c′ and d′ by the new wires of the second lattice. These are shown in dotted lines of which four are lettered SS, TT, UU, VV. It is true that we have smaller cells here—honeycomb cells, if you insist—as far as the mere question of looking down through the coil is concerned, but the successive cell wires are not "over" each other, as in the honeycomb coil. Their average self capacity is smaller. In both forms, in fact in all lattice coils, the cells get "flatter" as the coil gets larger, as will be shown later.

Figure 3 shows the cross-section of three wires and three layers of the "uni-lattice" winding taken at f f and figure 4 shows a cross section of three wires and three layers of the "bi-lattice" winding taken at f′f′. The latter is easily seen to possess less distributed capacity than the former—about 15 per cent. less on the average.

It is understood that the second lattice when finished, constitutes a complete separate system of honeycomb cells, whose walls are "staggered" half-way between the cell walls of the first lattice. Since a honeycomb coil is a "uni-lattice" or "mono-lattice" coil, the name "bi-lattice" has been given to this other form of winding. Only the alternate layers are started at the same circumferential point.

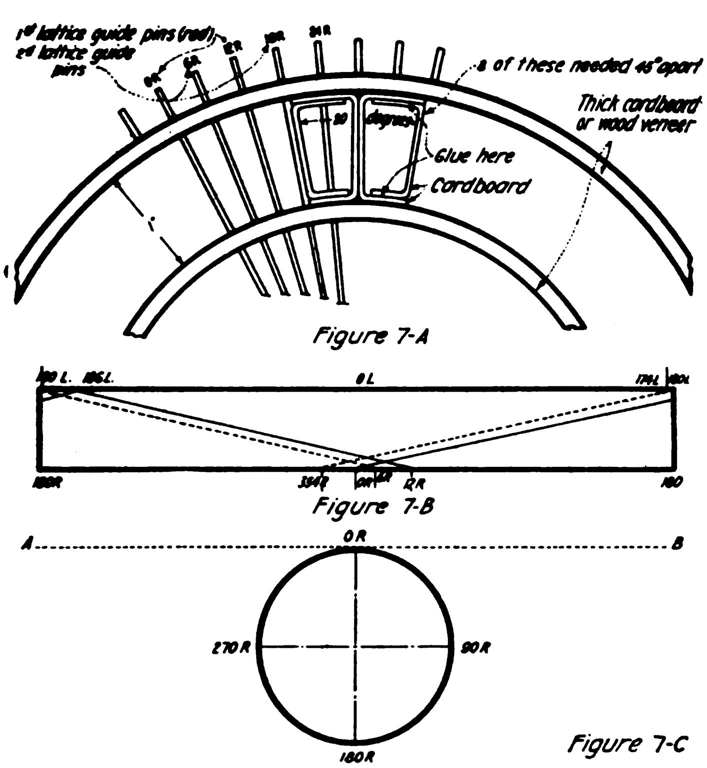
It was suggested in 1918 to engineers investigating the possibilities of further reducing the self capacity of the honeycomb coil, that by gradually shifting the starting point of the layers forward and then backward, as in figure 5, this self capacity would be reduced. This might be called a "quadri-lattice" coil or "multi-lattice" coil, as the series of lattices is repeated regularly.

However, it is not as good a reducer of capacity for given inductance as the bi-lattice winding, drawn to same scale in figure 6. This has a better selectivity at a given wave length.

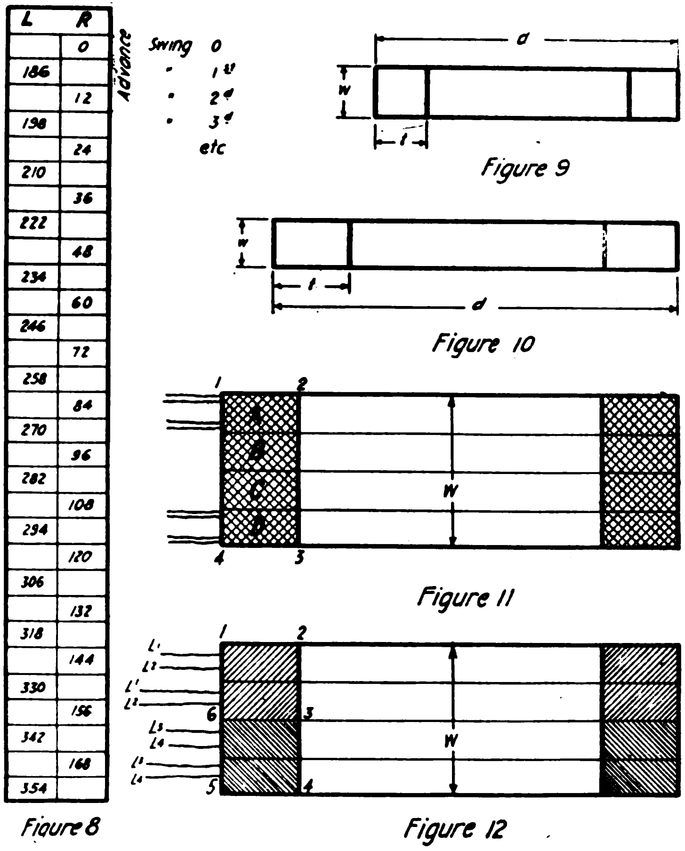
Study of Coil Lattices

There are two distinct but related problems to be considered in making a lattice coil:

First, how shall we make the winding repeat every "layer" regularly? The solution of all electrical requirements is based on this purely arithmetical problem, in addition to determining the size and kind of wire and the diameter and width of winding.



Figures 7A, B, C—Constructional details and method of winding bi-lattice coils



L	R
	0
186	
	12
198	
	24
210	
	36
222	
	48
234	
	60
246	
	72
258	
	84
270	
	96
282	
	108
294	
	120
306	
	132
318	
	144
330	
	156
342	
	168
354	

Figure 8

Figures 8 to 12—Chart and method of winding multi-lattice coils

Second, what is the best angular pitch to use in a coil of given lattice separation? This is determined by the number of turns and the coil width.

There is no exact analytical or even experimental engineering formula, it may be said, for the inductance of lattice coils. It is safe to recommend Professor Hazeltine's practical coil formula, presented at a meeting of the R. C. A. It is as follows:

This formula, based on Stephan's formula, is accurate to about 3 per cent.

$$L = \frac{.0008\, a^2 N^2}{6a + 9t + 10w} \text{ in milhenries.}$$

where a = mean radius of winding in inches
t = depth of winding in inches
w = width of winding in inches
N = total number of turns

In winding bi-lattice coils, it is not necessary to finish the first layer on one lattice, before starting the first layer of the other. This is especially evident in winding lattice coils by hand.

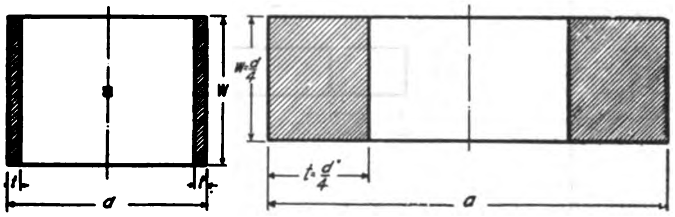


Figure 13 Figure 14

Figures 13, 14—Extreme and best ratios

To illustrate, place a double set of, say, red metal pins, No. 50 drill and about 2 inches long—equal in length to twice the coil winding depth—every 12 degrees around the circumference of a cylindrical coil frame, of say, 4 inches diameter and 3½ inches width. Place the holes within ⅛ inch of the faces of the frame. Then arrange another identical set of pins of different surface appearance 6 degrees away circumferentially from the first. Here we have the elements of a bi-lattice coil. We start one coil at OR on red pins only with 186 degrees swing, and another at 6 R, with the other pins only, with 186 degrees swing. Neither of these lattices will conflict, if wound by hand.

The finished coil is a bi-lattice coupler, and in large sizes cannot be surpassed for radio frequency work when used with proper "iron-dust-dielectric" in the lattices of the transformer. Transformers on this principle were tested as early as 1906. Figure 7a gives a sketch of the method. A wooden disk ¼ the width of the coil is used to support the inner cylinder of the winding frame.

In figures 7b and 7c we have a single lattice. In figure 7b it is shown in the form of a single layer, rolled out on the transparent imaginary surface A-OR-B, after being "cut" at 180 in figure 7c. The best way to gain an insight into the law giving the layout of the winding is to examine an actual winding chart to see whether it is practical or not.

Assume a "swing" of 186 degrees; make the "pitch"—which is 372 degrees—always twice the "swing." It happens that this first "pitch" is greater than 360 degrees, and the excess, which is called the "advance" is 12 degrees. The chart shows two things immediately.

First—There is room on this coil for a complete second lattice of the same description starting from the left at OL instead of the right at OR. This can be "hooked up" in series with the previous winding if a coupler is not desired, then we have a regular bi-lattice coil.

Second—The dotted lines in figure 7b are impossible under the above scheme, as winding swings. They cannot be covered by the chart-layout.

The winding chart shown in figure 8 indicates that several separate uni-lattice windings may be wound without in the least interfering with one another. The smaller the wire, the wider the coil and the smaller the "spacing" as shown in figure 4, the greater the number of separate "lattices" which can be wound. It is readily seen how windings started on 2R, 4R, 6R, 8R and 10R will give separate lattices. Thus by using six different double sets of colored pins as winding supports along the "right" and "left" faces of the coil frame, the experimenter may wind a sextuple lattice coil, by winding each lattice only on its own colored pins. The possibilities of various spacings and other winding factors will be treated in the next section.

Coil Dimensions and Winding Factors

We need to establish general limits within which lattice coil dimensions may be considered to conform to practical experience from mechanical considerations. If a coil form is satisfactory from the above standpoint, it may be left unsupported; as it should be mechanically rigid.

It may keep this rigidity through a large variety of windings, of very different electrical efficiencies, without appreciable mechanical change. In figure 9 we have sketched the kind of coil shown in figure 2 without indicating the lattices formed by the windings. This form gives a ratio

$\frac{d}{w} = 6$ and $\frac{t}{w} = 1$, changing the ratio $\frac{t}{w}$ to 2 and $\frac{d}{w}$ to 10 we obtain figure 10.

Four of these coils, placed close together, coaxially, have a very good time constant if connected in series. We may put this in other words by saying that in this case $\frac{d}{w} = 5$, $\frac{t}{w} = \frac{1}{2}$. Such an equivalent coil is shown in figure 11.

In the light of the "multi-lattice" windings indicated by figure 8, it is interesting to consider the four coils A, B, C and D as wound in a single coil "quadri-lattice" coupler. Every lattice has its pair of separate terminals. By various combinations a range of inductance of 1 to about 36 may be obtained.

A smaller range is obtained by winding the four "coils" of figure 11 as two "bi-lattice" couplers, as shown in figure 12. Each "coupler" with the same area of winding cross-section, 1, 2, 3, 6 or 6, 3, 4, 5 has two sets of terminals, and starts with a lower inductance than figure 11. The first lattice terminals are indicated by L_1L_1, the second lattice by L_2L_2 etc. These changes are really of no effect in determining a change of "swing," "pitch," or "advance," when changing the coil of figure 10 into the multi-lattice coupler coil of figure 11 or the two "bi-lattice" couplers of figure 12. The chart in figure 8 would do for any of them, as the "swing" is independent of the width, within wide limits.

The extreme case is shown in figure 13, where $\frac{d}{w} = 1$. This is about the limit of $\frac{d}{w}$. The depth of winding is that due to two "layers," and figure 13 could only by courtesy be called a lattice coil.

The best ratios to secure a high time constant are about $\frac{d}{w} = 4$, $\frac{t}{w} = 1$ shown in figure 14.

(*To be continued*)

EXPERIMENTERS' WORLD

Views of readers on subjects and specific problems they would like to have discussed in this department will be appreciated by the Editor

A Loop Transmitter for Local Work

By Albert F. Murray

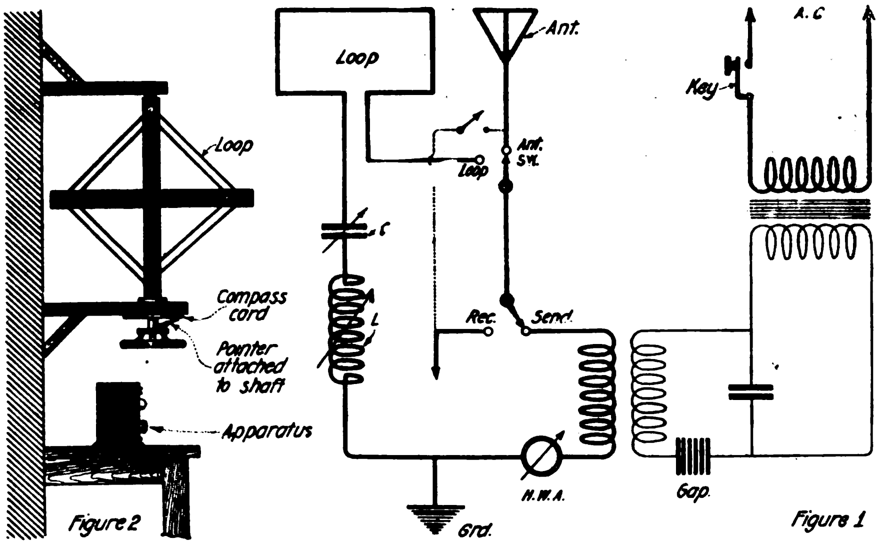
THE amateur of to-day is familiar with the characteristics of loop antennae, and is perhaps using or has used, some form of loop for receiving. Very few have tried transmitting on loops and up to the present, little has been written about this subject in radio journals. The reason for this, undoubtedly, is the shortened range of transmission when using a loop, although it will prove of great value to the amateur for short-distance or local work. The advantages, construction and operation of such a set follow.

A station desiring a short-range set would be of the more advanced type, possessing a non-synchronous spark transmitter of from ¼ to 1 kw. The short range work would be among amateurs using vacuum tube detectors, located in the same city or within 15 to 25 miles. The features desired are: sharp tuning, reduction of interference to or from other stations; a good spark note; a fool-proof break-in system with no contacts or moving parts; freedom from complication or duplication of parts. The necessity of two keys, two antenna switches, two sources of power, etc., is naturally to be avoided. All of these advantages are obtained by use of the loop for transmission and at the expense of one item, that is, low radiation efficiency. The power input is large compared to the distance covered. From the amateur viewpoint this is not a great disadvantage.

The wiring diagram of the station is shown in figure 1. To change from "long distance" to "local," throw switch SW from "antenna" to "loop." The additional apparatus required is the loop (described later); a high voltage condenser C, of any type whose capacity is approximately equal to that of your antenna, say .0003 mfd. or larger (it should be roughly adjustable in steps); and the inductance L, which is provided for fine tuning. If you do not mind moving the clip on the secondary of your oscillation transformer when changing from loop to antenna, you can tune in that way and omit inductance L, which is a helix of 4 turns, 12 inches in diameter.

In tuning proceed as follows:

With the transmitter in adjustment for maximum radiation on antenna, switch to loop and vary C until the H.W. ammeter reads highest. Shunt H.W. ammeter with a loop of copper wire, unless it will stand four times the ordinary current. Now vary L until a maximum antenna current is obtained. The settings for radiation on the antenna have not been disturbed and either aerial or loop can be used by throwing one switch. However, if maximum range on loop is desired by the experimenter, C should be increased, the secondary inductance of the oscillation transformer decreased, then retune and vary coupling for greatest current in loop. The tuning of the loop is much sharper than that of any antenna circuit because of the low resistance of the former. The coupling should be such that a wavemeter coupled to the loop should show but one "hump."



Figures 1 and 2—Circuit and construction of the loop transmitter

To operate swing loop so that the coil points in the direction of the station you wish to work. Receive on antenna and leave receiving set connected while sending. It is assumed that an audion is used as detector. Unless the loop and antenna lead are within a few feet of each other, it will be possible to wear the phones while transmitting and be able to hear other stations in the pauses between words. Not only can another station "break in" but you can hear when some loud interfering station starts up and send only during the times when he is not working, thus saving much time in repeating parts of messages lost due to QRM. Unless one has used such a system it is difficult to appreciate the advantages of being able to listen and talk at practically the same time. The grounding of one side of the loop decreases its directive properties somewhat, but experiments show that when the loop is pointing as much as 10 degrees away from a nearby station your signals at that station are inaudible. Of course, many factors, such as sensitiveness of receiver, etc., enter into the directional properties of the loop which, however, were found to be fairly pronounced and yet not too sharp. By using a receiving loop in a horizontal position it is said to be a "pick-up" loop receiving from all directions. Whether this is true of a transmitting loop and whether the range is decreased when in this position has not yet been experimentally determined.

It was found that work could be carried on through considerable interference when using the loop for reception. Low power amateur stations 10 miles away could be heard on a single tube, but a one step amplifier is necessary for satisfactory local work.

The loop used by the writer is 5 feet square, this being the largest size that could be handled easily in the operating room. It is mounted above

(Continued on page 41)

A Sensitive Portable Receptor

By Francis R. Pray

FIRST PRIZE, $10.00

IN the past, amateurs generally depended on a crystal rectifier for the operation of their portable receiver due to the instability of the early types of gas filled audion tubes. Although they saved in space and weight, the results obtained with the crystal equipped set were not encouraging.

Now that a rugged vacuum tube has been developed for amateur use which can be used with comparatively small plate potentials and low filament current consumption, the practicability of including an audion detector in the portable outfit is an accepted fact, and with it goes the following advantages:

(1) Maximum efficiency at the detector.

(2) Elimination of the buzzer test and battery.

(3) Constancy of operation.

(4) By employing the oscillating characteristics of the tube, regeneration or amplification is obtained on spark signals and continuous wave signals may be received.

The one primary obstacle in the use of a VT, is the "A" and "B" battery problem. Most portable sets are taken to destinations which make impossible the use of a storage battery and even if charging facilities are at hand, storage batteries are a bad proposition for field use, as any Signal Corps man will affirm.

Really the only solution possible is the use of ordinary No. 6 dry cells. It would be impracticable to carry along more than a single series—3, to give 4½ volts—as six, in series multiple, although having longer life, would add too much weight to the outfit. As a Marconi-Moorhead VT requires about .65 amps. to light the filament to full brilliancy, it can be estimated that the battery will last about twenty operating hours before becoming useless. The inherent recuperative powers of the No. 6 cell may extend this time limit, depending on how the battery is treated.

Many VT's will operate with the 22-volt potential derived from a Signal Corps size "en bloc" B battery but it would be advisable to include a couple of small flashlight batteries with Fahnestock clips for terminals, as many tubes require increased plate potential with continued use.

Fahnestock terminals are ideal for binding posts on portable outfits as the wires cannot jar loose, connections are easily made, and there are no thumbscrews to lose.

The next most important consideration is the selection of the circuit. It is at once apparent that an inductively coupled circuit is not required, as a broadly tuned circuit allows the reception of "everything in the air." More and more radio men are conceding that the single coil circuit is the most efficient for all-around reception, except perhaps in 200-meter reception and in long wave continuous wave reception.

In the circuit shown herewith, all that is necessary is one coil in the tuning circuit, which need not be variable if interchangeable coils such as the De Forest plug inductances are used. All the tuning variation is done with the .001 mfd. condenser and the circuit can be made to oscillate at any point on the condenser scale by variation of the grid condenser. This makes a fairly good regenerative circuit, also, when the condenser values are set at a point just previous to that where oscillations begin.

The most practical form of inductance to use is unquestionably the universal wound coil, which is sold with a plug mounting by the De Forest establishment. Of course the amateur may buy the Radisco coils at a slight saving and equip them with a self-constructed plug with a little ingenuity. The separate brass plugs and sockets used on these plugs can now be obtained separately from the Somerville Radio Laboratory, enabling the radio constructor to devise all sorts of original honeycomb coil mountings at a very low comparative cost.

Reference to the drawings will show the best form of arranging the apparatus. These are drawn to scale, to conform with the dimensions of standard apparatus, but exact dimensions are not given as the constructor can use material already on hand, in many cases, thereby making necessary the enlarging of the cabinet. Roughly speaking, the entire outfit may be placed in a cabinet of half inch oak, 8 x 8 x 8 inches.

The front can be a sheet of 3/16 inch Bakelite or Micarta held in by brass angle strips. The sheet when removed, makes an excellent writing surface for copying messages, and also cuts down weight. The use of Bakelite as constructional material in the instrument compartment also cuts down weight, and makes the mount-

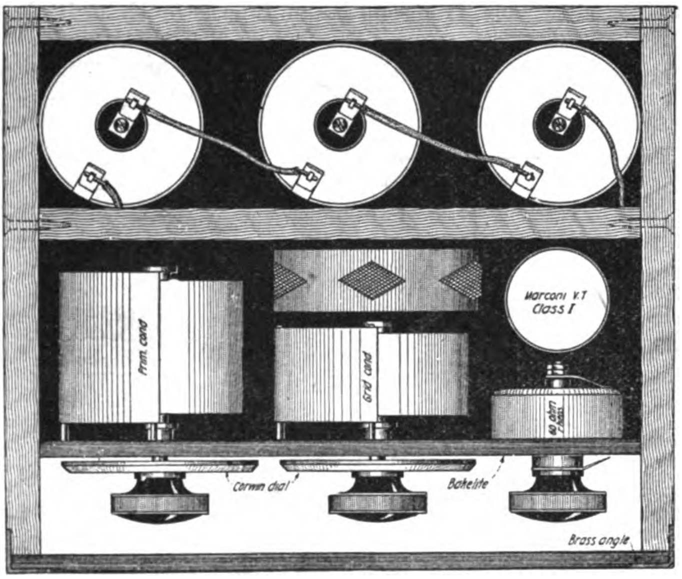


Figure 1—Top view of panel showing arrangement of instruments

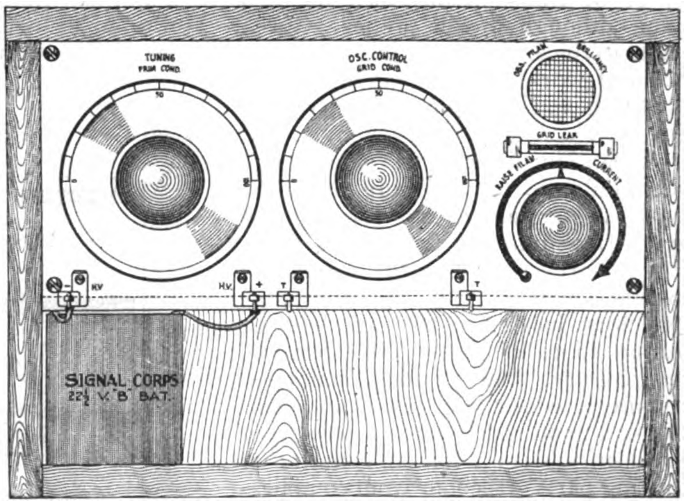


Figure 2—Front view showing controls and lower compartment for storing extra coils, phones, etc.

ing of same much easier. The material may be drilled and tapped and held together with machine screws. 4-36 thread screws are the proper size to use on 3/16 inch stock.

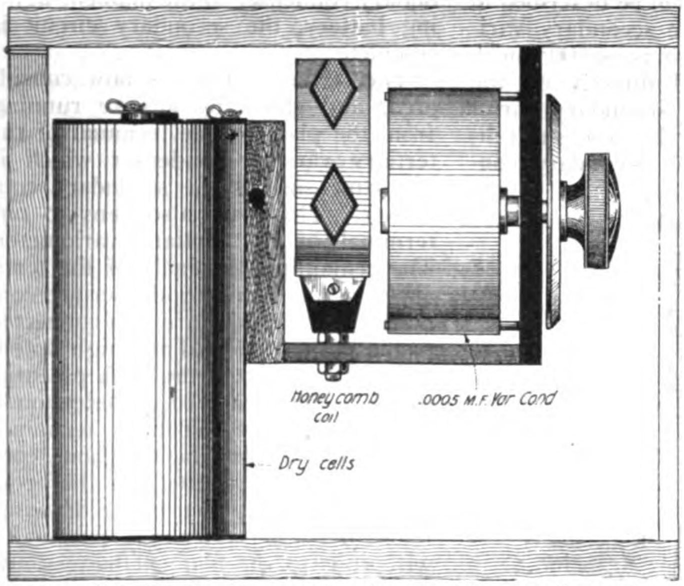


Figure 3—Side view showing mounting of coil direct to bakelite housing

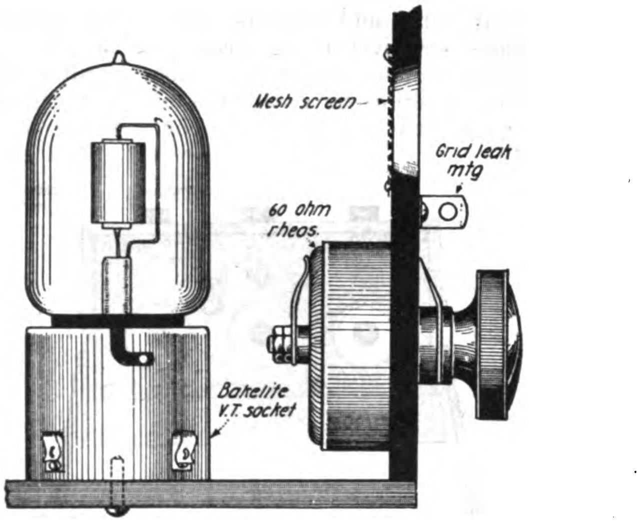


Figure 4—View of "VT" mounting, rheostat and grid leak

The neatest and most compact condenser arrangement is the Radio Equipment condenser equipped with a Radisco dial. The most compact VT socket is one made of Bakelite by a Massachusetts radio company, advertising in Wireless Age. It is equipped with Fahnestock terminals and contacts of phosphor bronze.

The most desirable rheostat for the VT filament regulation is unquestionably the Paragon as it is only 2⅛ inches in diameter and very easily and neatly back-mounted. Its "off" position obviates the need of the usual "on-off" filament circuit switch. A number of fine holes may be symmetrically bored to observe filament brilliancy or a large 1-inch hole may be cut and covered with a metal gauze screen. The 2-megohm Marconi grid leak may be purchased without the base, and held on the panel by two spring metal clips. Fahnestock binding posts should be used and the No. 6 dry cells should also be purchased equipped with them. Although Murdock No. 55 phones are not necessarily the best, they can be packed very compactly, are light in weight, and their small cost discounts worry, if the set is dropped in the lake or lost in a forest fire, etc. Signal Corps P-11 phones are very good for field use, but don't take anything to camp which you prize highly.

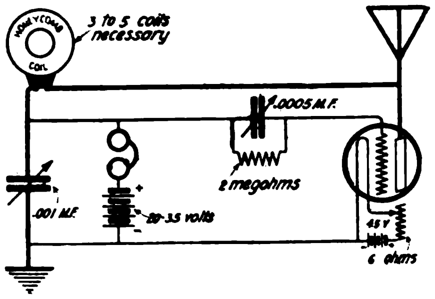


Figure 5—Single coil arc, regular spark circuit used

When going into unknown territory, the best antenna proposition is a couple of 100-200 feet coils of common annunciator wire, one for the antenna and the other for the counterpoise, to serve in lieu of a ground. Don't forget to include plenty of pencils and writing paper, which may be wrapped in oiled paper and stowed away between the dry cells.

While there are many other practical suggestions which might be made, in closing, let me suggest that you commission some obliging friend or radio company to send by parcel post to the nearest mail destination another set of dry cells, and perhaps a fresh B battery, after a few weeks, as they may come in mighty handy if something should go wrong with the first set.

Portable Receiver

By Norman A. Nyquist

SECOND PRIZE, $5.00

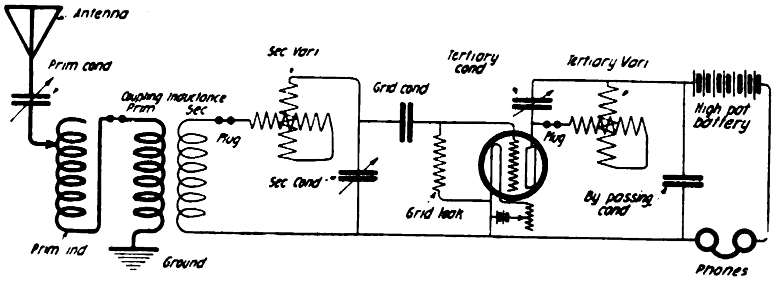


Figure 4—Schematic wiring diagram of the portable receiver

During the summer, most amateurs leave their stations to go on vacations or to other towns to work for the season and consequently have no apparatus to experiment with, as the transportation and erection of their existing equipment would be difficult. In these warm months, the ideal receiver would be one that could be set up in the open and used to receive wave-lengths from 150 to 3000 meters and which could also be installed indoors as well, in a few moments.

The following described receiver was designed for portable work, and by removing the cover, a perfectly satisfactory instrument for permanent station work is available. The design of an efficient receiver to cover a wide range of wavelengths is very difficult unless sufficient space and complicated mechanical movements are permitted; that is, if it is to be automatically operated. It is believed that manual operation to secure changes to the upper range of wavelengths will be satisfactory for amateur purposes.

Referring to figure 4, a schematic wiring diagram of the proposed receiver is shown. Starting at the antenna, we come to the primary variable condenser. This condenser is mounted by itself and should have one of the rotor plates bent over at the corner so that it will short-circuit itself in the 180 degree position, as it will not be used for some wavelengths. This condenser should have a capacity of about .0008 mfd. and work through a 180-degree scale. It is preferable to buy a standard condenser and arrange for mounting it on the front panel.

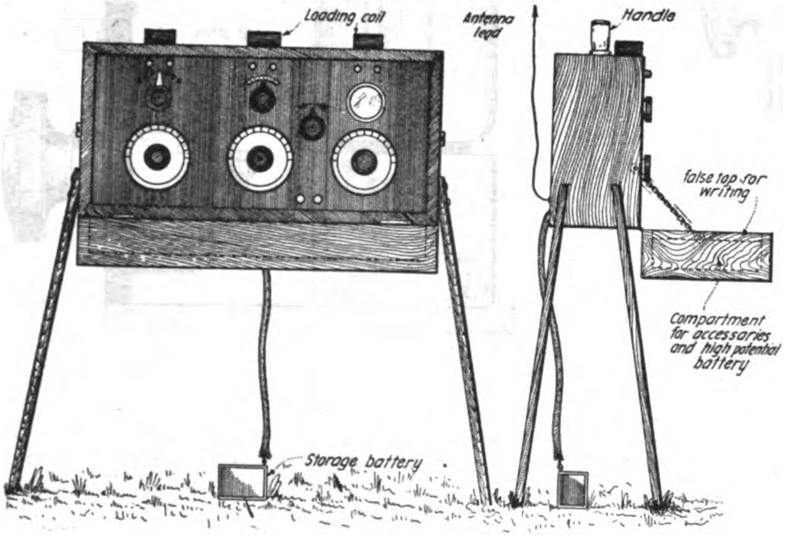


Figure 1—Front and side view of assembly

Next we come to the primary loading inductance. This is a small cardboard or dilecto tube two inches in diameter and three inches long, wound with 120 turns of 27-38 Litzendraht or No. 22 d.c.c. copper wire, bank wound, two layers. Taps should be taken every twelve turns and brought out to a 10-point switch on the front panel. When finished, the winding should be baked dry and given two coats of a good insulating varnish.

Following the primary loading inductance, is the primary coupling inductance, which is a fixed winding with no taps. A small tube three inches in diameter and two inches long, is wound with 20 turns of the same size wire, single layer, which will leave sufficient room at the other end of the tube, for fastening a bracket to mount the tube to the panel. One end of the primary coupling inductance runs to the ground and completes the primary tuning circuit.

The secondary circuit is now to be considered. The secondary coupling inductance consists of ten turns of the same wire wound on a small disc ⅝ inch wide and 2¼ inches in diameter. It should be baked and varnished. This is the movable coil shown in the sketches and swings through 90 degrees and is controlled by the handle with pointer shown in figure 2, marked coupling.

From the coupling inductance we come to the secondary variometer, which construction will be described in detail later on. The secondary variable condenser which is of .005 mfd. capacity is mounted directly on the front panel and the secondary variometer is mounted on the same shaft directly in back. The secondary condenser is in shunt to the secondary coupling and variometer inductance, which are in series.

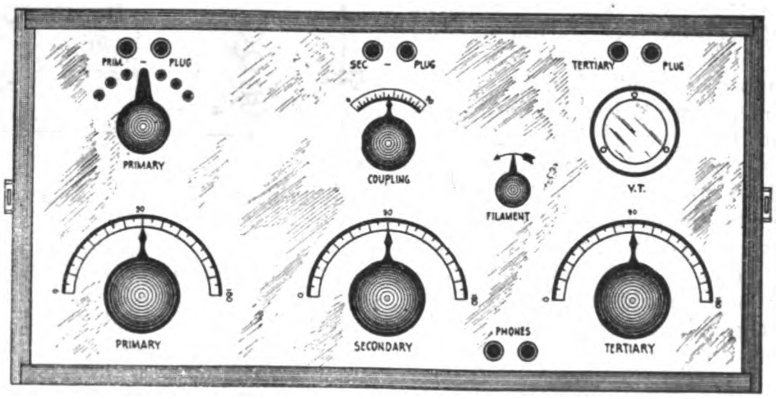


Figure 2—Front view showing location of instrument controls

One lead of the variometer runs to the grid condenser. This condenser consists of four copper discs one inch in diameter, two connected to one side and two to the other, insulated from each other by 1½-inch discs of mica .005 inch thick. This condenser should be dipped in a good insulating varnish and dried. A small bolt insulated from the plates can be passed through the center and fastened to a bracket for mounting to the front panel from the rear. The other lead of the grid condenser runs to the grid of the VT audion and also the one terminal of the grid lead, which should be 2 megohms for ordinary VT tubes. As shown, the other lead of the grid leak runs to the positive side of the filament lighting battery.

After another wire is run from the other terminal of the coupling inductance to the other terminal of the secondary condenser to the filament lighting battery, the secondary circuit is complete.

The tertiary circuit is now considered, and starts by a wire running from the plate to one terminal of the tertiary variable condenser which is the same size as the secondary condenser. This wire also runs to one terminal of the tertiary variometer. The remaining terminals of the tertiary variometer and condenser are connected together and are also connected to the positive side of the high potential battery. From the high potential battery a wire runs to the telephones. In this case the telephone terminals are two jacks for the telephone cord plugs and are mounted on the front of the panel as shown in the drawing. From the other telephone terminal a wire runs to the filament battery and completes the tertiary circuit, with the exceptions of the by-passing condenser for battery. This is a small condenser to allow the high frequency oscillations to pass around the high resistance offered by the telephones and high potential battery and is exactly the same as the grid condenser except that there are four discs of copper on each side, eight in all.

On the filament lighting circuit a variable resistance is in circuit, to properly adjust the filament to the proper temperature for best operation and long life. The Adams-Morgan Co., Montclair, N. J., is putting out an excellent rheostat suitable for this purpose and comes ready to mount on the panel, from either the front or rear. The resistance is suitable for VT tubes on operation from 4 to 6-volt batteries.

The most difficult part of the receiver to build will be the variometer, and well spent skill on this portion of the construction will be repaid in results. Referring to figure 5, it will be noted that the variometer is extended directly on the secondary and tertiary variable condensers, and that there is no variometer on the primary condenser (figure 3).

Either a new extended shaft will have to be put through the rotor plates of the variable condensers, or the end of the shaft can be tapped and an extension threaded in and sweated with solder which will be satisfactory. A frame of dilecto is then made to hold the stator windings. This is simply two pieces spaced with brass rods and fastened to the rear end dilecto piece of the condenser. The windings are held in place by small aluminum brackets that are screwed to the dilecto frame pieces. The windings are then tied in place with strong linen thread and waxed. The rotor windings are held in a similar manner. The shaft runs through a dilecto rectangular block and is split in the middle and then the shaft continues through the other half of the dilecto block out the rear end. This shaft is split so that each of the two rotor winding ends can be brought out through one half of the shaft. The middle two connections of the rotor winding are connected together so that the winding is in a continuous direction.

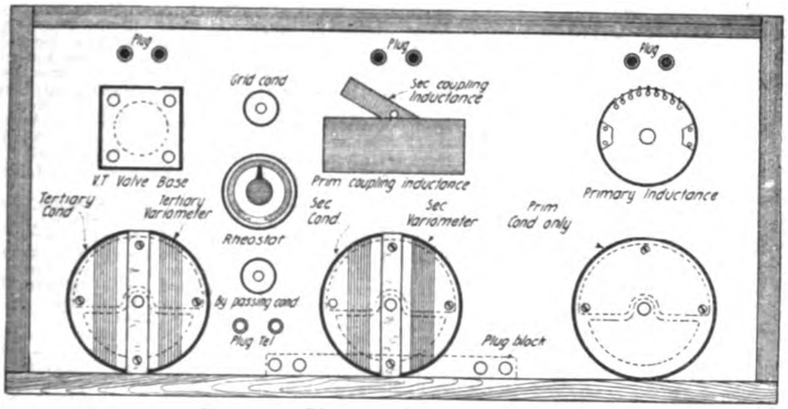


Figure 3.—Diagram of panel arrangement

Variometer winding is shown in the small sketch in figure 5. Preferably wooden forms are turned in a lathe the exact groove being cut as per sketch. The form should be made in such a manner that it can be taken apart to remove the winding. Before the windings are removed, the wires are firmly waxed together with a medium hard wax. It will be found that the windings will keep their form and a very substantial variometer can be constructed.

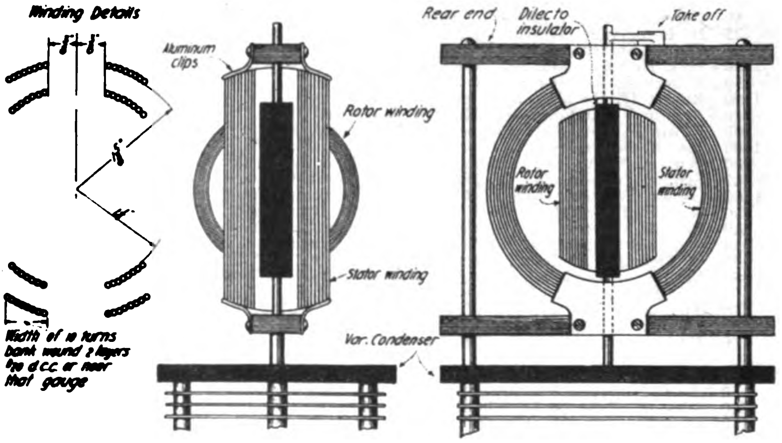


Figure 5.—Variometer and winding details and secondary and tertiary condensers

Now as to the assembly. A possible arrangement is shown in the assembly drawings. The front panel is dilecto which is the best material for this purpose and well worth the money it costs. Looking from the rear the tertiary condenser and variometer are at the extreme lower left end, and the secondary condenser and variometer at the lower center. True, there is some permanent coupling between these circuits, but it will not be detrimental to their operation. The primary condenser is at the extreme lower right. The primary inductance is at the upper right end of the receiver and is perpendicular to the panel. The primary coupling inductance is at right angles to the primary load and has no coupling to it. The secondary coupling inductance has no permanent coupling to the primary load in any position.

The VT tube, rheostat and fixed condensers may be mounted as shown or in any position convenient to the individual requirements. It will be noted that the telephone plugs in from a jack on the front of the panel. The antenna, ground, high potential battery and storage battery are connected to the receiver through a small terminal block on the rear of the receiver which is not covered when the case is on. The case may be of oak.

Three leg fastenings are to be made of sheet metal and fastened on the case to hold the legs. The legs should be of oak, about eighteen inches long. It is figured that the legs will hold the receiver sufficiently above the ground to allow an operator to sit at the receiver with his legs straight out under the receiver, while sitting on the ground.

As designed the receiver will cover a range of 175 meters to 875 meters which is best for experimental purposes. However, as shown in the schematic wiring diagram, plugs are provided to insert loading inductances in the primary, secondary and tertiary circuit and the receiver may be loaded up to 2500 meters, and used for both damped and undamped reception.

In regard to its operation: Assuming that we did not know the wavelength that was to be received, first, we would tighten the coupling by setting the dial at 75 degrees on the scale, then short circuit the primary condenser by moving it into the 180 degree position. Of course, telephones are now plugged into the jack. Loading coils are short circuited, valve lit and the high potential battery connected and filament adjusted to normal temperature. The tertiary circuit control is set at 0 degrees on the scale. By simultaneously moving the primary inductance switch and secondary circuit control we will cover the range of 175 and 875 meters. It is best to hover around 600 meters as most stations work on that wavelength. When signals are heard, first adjust the primary inductance to the exact point; if this cannot be done directly with the inductance, increase the inductance and throw the primary condenser in series and tune with that. The secondary circuit and coupling should then be adjusted, the coupling being reduced to a point where signals are the best and still readable, and still further if interference is prevailing. Now by moving the tertiary circuit control slowly toward the 180 degree position, we start to tune the plate circuit and the valve regenerates and the signal strength is increased. This increase will continue until the valve starts to oscillate. Of course, then the spark resembles a hiss.

If we are to tune to undamped stations, the valve must be oscillating all the time, and tuning done by the heterodyne method. Indications of oscillations are noted in many ways, but a sure indication is a dull thud as the tertiary is moved from the 0 position to the 180-degree position. After the thud, the static has a different tone.

(*Continued on page 41*)

Second District Call Letters of Amateur Stations

(Continued from June Wireless Age)

Letters.	Power.	Name and address.
2IO	50	Raymond B. Cunningham, 60 Park Pl., So. Orange, N. J.
2IP	440	Wm. E. Ashmall, Jr., 11 Pavonia Ave., Arlington, N. J.
2IQ	60	F. A. Gritzner, care J. W. Hatch, 430 W. 122nd St., N. Y. C.
2IR	1000	J. W. Hubbard, 327 King St., Port Chester, New York.
2IS	500	Harold T. Daily, 25 Lydecker St., Nyack, N. Y.
2IT	1000	Norman C. Cowper, 454 Merrick Road, Lynbrook, N. Y.
2IU	500	N. Leo, 35 Pt. Washington Ave., New York City.
2IV	50	Walter J. Lans, 17 Grant Ave., Lynbrook, N. Y.
2IW	600	Jno. B. Worth, Cresskill, N. J.
2IX	550	S. W. James, 37 43rd St., Irvington, N. J.
2IY	500	Alex Dougan, 26 Spencer Ave., Lynbrook, N. Y.
2IZ	50	Melville G. Kilborn, 349 Valley Road, West Orange, N. J.
2JA	275	David Carruthers, 135 Waverly Place, New York City.
2JB	50	Wm. J. Miller, 126 Orient Ave., Jersey City, N. J.
2JC	100	Joseph Chambers, 142 W. 126th St., New York City.
2JD	275	John H. Janco, 121 Park St., Schenectady, N. Y.
2JE	1000	J. L. Eddy, Jr., 23 Washington Ave., New Rochelle, N. Y.
2JF	25	Anton C. Frey, 208 Freeman Ave., Jersey City, N. J.
2JG	750	J. E. Judson, 89 Third St., Keyport, N. J.
2JH	25	Wm. B. Fricke, 156 N. Arlington Ave., East Orange, N. J.
2JI	500	Robt. P. Norris, 906 St. Marks Ave., Brooklyn.
2JJ	25	J. Kulik, Rot Seminary, Tenafly, N. J.
2JK	150	A. H. Bardewyck, 30 Bay 31st St., Brooklyn, N. Y.
2JL	500	Jos. Roemisch, 841 Lexington Ave., New York City.
2JM	200	Louis Tepel, Jr., 176 East 109th St., New York City.
2JN	250	C. K. Atwater, 40 Oakwood Ave., Upper Montclair, N. J.
2JP	12	H. M. Bruden, 141 North 17th St., East Orange, N. J.
2JQ	300	G. F. Abderholden, 659 Henry St., W. Hoboken, N. J.
2JR	50	Leon Terwilleger, Clermont, N. Y.
2JS	25	Thos. J. Smith, 624 Summerfield Ave., Asbury Park, N. J.
2JT	500	F. F. Dennis, Main St., Fair Haven, N. J.
2JU	1000	C. J. Goette, 1624 Hamilton Ave., Woodhaven, L. I.
2JV	50	Eric Hilmer Berg, Main St., Pearl River, N. Y.
2JW	25	G. W. Stewart, 171 Kearny Ave., Perth Amboy, N. J.
2JX	50	Julius Cohen, 545 W. 158th St., New York City.
2JY	30	O. J. Goohs, 298 Palmetto St., Brooklyn, N. Y.
2JZ	1000	C. F. Mueller, Jr., 440 Monroe Ave., Elizabeth, N. J.
2KA	50	G. A. Webster, Sterling Ave. & West St., Harrison, N. Y.
2KB	1000	E. A. Schabbehar, 412 Village Ave., Rockville Centre, N. Y.
2KC	50	Robert W. Scofield, 267 Halsey St., Brooklyn, New York.
2KD	500	W. S. Browne, 1565 E. 12th St., Brooklyn.
2KE	50	Donald Lefever, 305 Fird St., Ogdensburg, New York.
2KF	25	H. D. Selvage, 45 Durand Place., Irvington, New Jersey.
2KH	55	Walter Solberg, 620 46th St., Brooklyn.
2KI	1000	Jack Hoffman, 462 Ft. Washington Ave., New York City.
2KJ	50	Robert Taylor, 464 Pacific St., Brooklyn, N. Y.
2KK	1000	Robert H. Horning, 34 Westfield Ave., Roselle Park, N. J.
2KL	220	Arthur V. Gregory, 105 Hudson Ave., Red Bank, N. J.
2KM	100	Edwin F. Jones, 311 Prospect St., Westfield, N. J.
2KN	1000	Jas. K. Noble, 441 N. Broadway, Yonkers, N. Y.
2KO	500	Wm. A. Smith, 561 Midland Ave., Midland Beach, N. Y.
2KP	500	Samuel Jackson, 345 W. 88th St., New York City.
2KQ	1000	Osmun W. Lorini, 96 Highland Ave., Yonkers, New York.
2KR	250	Geo. F. Harrington, 436 Ford Hall, New Brunswick, N. J.
2KS	530	Ed. M. Mowton, 70 Hillcrest Ave., Yonkers, N. Y.
2KT	250	Merle E. Robertson, 98 Piermont Ave., Nyack, N. Y.
2KU	500	O. Oehman, 29 New Jersey Ave., Brooklyn, New York.
2KV	50	Walter A. Remy, 356 Desmund Ave., Bronxville, New York.
2KW	50	Jas. R. Plummer, 340 Orient Way, Rutherford, N. J.
2KX	50	Theron W. Kilmer, 165 W. 85th St., New York City.
2KY	500	Wm. V. M. Spader, 103 1st Ave., Highland Park, N. J.
2KZ	30	Kenneth W. Spalding, 501 Argyle Road, Brooklyn, N. Y.
2LA	50	A. R. de Rouville, 21 Barrow St., Albany, N. Y.
2LB	50	A. T. Newborg, 421 Brook Ave., New York City.
2LC	550	Alex. P. Roberts, Tenafly Road, Tenafly, New York.
2LD	550	O. A. Morris, 817 Lenox Road, Schenectady, New York.
2LE	250	R. S. Egolf, 45 Pearl St., Oceanside, New York.
2LF	25	Wm. W. Earnest, 161 6th Ave., W. Roselle, N. J.
2LG	50	C. B. Adams, 179 Hudson Ave., Red Bank, New Jersey.
2LI	165	F. C. Meacham, 30 Linden Ave., Brooklyn, N. Y.
2LJ	500	Henry A. Weber, 227 Oak St., Weehawken, New Jersey.
2LK	25	Wm. L. Wheeler, Jr., 348 W. 22nd St., New York City.
2LL	48	A. R. Benedict, Newburgh, R. D. 1., Newburgh, N. Y.
2LM	500	A. Davidson, 347 W. 122nd St., New York City.
2LN	660	C. P. Morrison, 2513 Catalpa Ave., Glendale, New York.
2LO	500	N. Dunham, 103 S. 1st Ave., Highland Pk., New Jersey.
2LP	500	Cecil J. Reed, 26 College Pl., Newark, New Jersey.
2LQ	500	E. K. Cohan, 601 W. 156th St., New York City.
2LR	1000	E. T. Erickson, Marion Ave., Harrison, New York.
2LS	50	Everett Decker, 2100 Richmond Ter., Port Richmond, N. Y.
2LT	550	Norman C. Hall, 157 Roseville Ave., Newark, New Jersey.
2LU	500	George Beluze, 308 Angeleque St., West Hoboken, N. J.
2LV	500	H. M. Bargebuhr, 719 W. 180th St., New York City.
2LW	50	Everett N. Sider, 55 Ward Place, South Orange, N. J.
2LX	50	B. A. Hampe, 1228 Putnam Ave., Brooklyn, N. Y.
2LY	50	Chas. A. Wood, 353 Heberton Ave., Port Richmond, N. Y.
2LZ	500	Robert Schultz, 2261 Chatterton Ave., New York City.
2MA	1000	Earl Hasbrouck, Wallkill, New York.
2MB	50	Morris Press, 839 Thrall Ave., Woodhaven, Long Island.
2MC	50	Benville H. McMann, 380 Riverside Drive, New York City.
2MD	16	Manney F. Dinovo, 2305 13th St., Troy, New York.
2MG	500	H. E. H. Knight, 251 Fenimore St., Brooklyn.
2MH	50	Howard E. Anderson, 23 Liberty St., Ridgewood, N. J.
2MI	500	Earle S. Morris, 1192 Dean St., Brooklyn, N. Y.
2MJ	50	Gerard Ferre, 390 Oakland Ave., West Brighton, N. Y.
2MK	15	H. C. Midgley, 59 Brewster St., Stapleton, New York.
2ML	125	Albert M. Luxtig, 444 15th St., Brooklyn, N. Y.
2MM	50	Frank M. Soden, 1282 Hancock St., Brooklyn, N. Y.
2MN	500	Philander H. Betts, 238 Valley Road, Montclair, N. J.
2MO	48	S. Tannenbaum, 155 Seigel St., Brooklyn, N. Y.
2MP	24	R. Wolf, Jr., 431 Van Dyke Ave., Haledon, New Jersey.
2MQ	250	T. B. Comstock, 195 Fernwood Av., Up. Montclair, N. J.
2MS	50	Jos. B. Hunter, 910 Kilsyth Rd., Elizabeth, N. J.
2MT	1000	Abram W. Moses, 270 E. 161st St., New York City.
2MU	220	W. O. Schmidt, 2076 Daly Ave., New York City.
2MV	500	John J. Dane, 92 Third St., Keyport, New Jersey.
2MW	25	H. B. Wattson, 251 Union Ave., Rutherford, New Jersey.
2MX	575	C. B. LeGallez, Slingerlands, New York.
2MY	500	Edwin K. Cohan, 601 W. 156th St., New York City.
2MZ	50	T. J. Mulvaney, 1911 White Plains Ave., Van Nest, N. Y.
2NA	100	Nelson Aseltine, 209 Edgewood Ave., Westfield, N. J.
2NB	18	Chas. C. Cahn, 182 Pulaski St., Brooklyn.
2NC	25	Russell N. Chappell, 338 Stanley Ave., Tompkinsville, N. Y.
2ND	50	Howard R. Hill, 15 Albion Place, Port Richmond, N. Y.
2NE	12	A. H. Saxton, 211 Claremont Ave., Jersey City, N. J.
2NF	990	Wm. G. Mayer, N. Bath & Wilson Ave., L. Branch, N. J.
2NG	25	H. Opperman, 42 Grand Ave., Baldwin, Long Island.
2NH	750	H. E. Ballentine, 51 Ann St., Pt. Richmond, New York.
2NI	50	D. Truex Buck, 116 W. Main St., Freehold, New Jersey.
2NJ	24	James E. Rossner, 5 Ditson Pl., Albany, N. Y.
2NK	500	Wm. K. Johnson, 501 Jersey Ave., Spring Lake, N. J.
2NL	500	John R. Bucknam, 4 Hemlock Place, New Rochelle, N. Y.
2NM	25	C. M. Bleiley, 43 Hamilton St., E. Orange, New Jersey.
2NO	500	Frank P. Merritt, 28 Spring St., Red Bank, N. J.
2NP	1000	N. B. Foot, So. Bway., Nyack, New York.
2NQ	50	Algot Eiserman, Ridge St., Pearl River, New York.
2NR	500	L. R. Flynn, Lincoln Ave., Sayville, New York.
2NS	30	C. R. Doty, 928 Orchard St., Peekskill, New York.
2NT	500	E. F. Glavin, 64 Scarsdale Ave., Yonkers, New York.
2NU	500	Hugh M. Henry, 21 Oakview Ave., Maplewood, New Jersey.
2NV	600	Frank S. Miller, 153 Fifth St., Weehawken, New Jersey.
2NW	770	R. B. Austrian, 49 St. Nicholas Terrace, N. Y. C.
2NX	250	R. G. Johnston, 21 So. Main St., Freeport, N. Y.
2NY	50	Nomer Gray, 301 St. Nicholas Ave., New York City.
2NZ	500	Elmer Raguse, 450 Elliott Ave., Tottenville, S. I., New York.
2OA	1000	Lester P. Hammond, Tarrytown Rd., Valhalla, New York.
2OB	500	J. T. Harahan, Beach & 133rd St., Belle Harbor, L. I., N. Y.
2OD	220	R. R. Schleckser, 118 Fabyan Pl., Newark, New Jersey.
2OE	1000	S. L. Raynor, Cottage Court, Freeport, New York.
2OG	200	A. B. O'Hara, 941 Washington Ave., New York City.
2OH	27	L. H. Armbruster, 11 Rockwood Ave., Baldwin, L. I.
2OI	50	H. E. Anderson, 60 Hanford St., Middletown, N. Y.
2OJ	500	Benj. Solarz, 1540 48th St, Brooklyn, N. Y.
2OK	200	Oscar Johnson, 501 W. 134th St., New York City.
2OL	250	R. L. Dougherty, 539 W. 155th St., New York City.
2OM	100	F. B. Ostman, 89 So. Van Dien Ave., Ridgewood, N. J.
2ON	72	E F. Bona, 82 Van Nostrand Ave., Jersey City, N. J.
2OO	200	R. T. Hawkey, 29 Virginia Ave., Poughkeepsie, N. Y.
2OT	200	W. C. Boerner, 34 Britton Ave., Elmhurst, Long Island.
2OU	550	T. J. Berger, 2626 Bway., New York City.
2OV	21	Y. A. Golobe, 1248 St. Johns Pl., Brooklyn, N. Y.
2OW	500	W. H. Tirrell, 20 Rutland Rd., Brooklyn.
2OY	16	J. Schanz, 230 E. 18th St., New York City.
2OZ	16	C. H. Hild, 165 Luquer St., Brooklyn.
2PA	660	J. H. Boolley, 1743 Montgomery Ave., New York City.
2PB	246	B. Tyler, 79 Winthrop St., Brooklyn.
2PD	160	Wm. A. Ward, 917 Gates Ave., Brooklyn.
2PE	275	H. Ronclere, Hotel Ronclere, Ridgewood, New Jersey.
2PF	500	D. Talianoff, 817 E. 16th St., Brooklyn.
2PG	50	Peter Jasko, Freehold, New Jersey.
2PI	550	J. W. Schmidt, 502 W. 143rd St., New York City.
2PJ	500	Alonzo E. Thomas, Jr., 147 Lincoln St., Jersey City, N. J.
2PK	500	H. Reifel, 489 Columbus Ave., New York City.
2PL	462	G. K. Thompson, 139 Maplewood Ave., Maplewood, N. J.
2PM	650	Adolph J. Faraon, 808 West End Ave., New York City.
2PN	50	Henry C. Berger, 33 Pennington Ave., Passaic, N. J.
2PO	945	W. T. Feeney, 819 McLean Ave., Yonkers, N. Y.
2PP	8	W. F. Scott, 207 N. 11th St., New Jersey.
2PT	50	Clifford H. Hammill, 208 Locust Ave., Port Chester, N. Y.
2PU	990	Jos. I. Lally, 117 27th St., Guttenberg, New Jersey.
2PV	21	H. H. Ammenheuser, 314 1st St., Albany, New York.
2PW	500	Wm. Hellman, 753 Jefferson Ave., Brooklyn, N. Y.
2PY	250	Carl J. Hunkins, 26 Washington Place, Glen Ridge, N. J.
2PZ	12	Harry Sadenwater, 1333 Lexington Ave., New York City.
2QA	500	W. S. Benson, 4 Fuller Pl., Brooklyn.
2QB	500	H. W. Blackford, 220 Park Ave., Plainfield, N. J
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2QI	10	Alfred C. Oechler, 82 Smith St., Irvington, N. J.
2QK	616	A. K. Ransom, 701 W. 179th St., New York City.
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A Universal Range Portable Receiver

By Chas. T. Jacobs

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WITH the coming of the various multilayer coils into general use, the problem of the construction of a portable receiver to cover the complete range of wavelengths has been greatly simplified. Believing that there is now no obstacle to the construction of a truly universal receiver that would be truly portable, the writer has designed and is now constructing for his own use the receiver described.

The receiver is completely enclosed in a covered cabinet or case 6 x 12 x 13¾ inches, with bakelite panel for controls. It is designed primarily for use with the vacuum valve, either regenerative or simple rectifying action being obtainable at will. Binding posts are provided, however, for a crystal detector, which may be used when desired. The receiver accommodates multilayer coils of present-day design. These are to be obtained or made unmounted and a small block of wood, with a hole therein, glued firmly to the inside of each coil, as shown in figure 1. These blocks are made of wood about the same thickness as the coil, and are laid out, drilled and cut on the heavy lines, making six blocks at once.

A rod onto which the coils needed for a certain range of wavelength are slipped, is then set in notches provided for it. Flexible leads from the coils are then connected to the proper binding posts. Coupling is varied by sliding the coils along the rod, there being no tendency for the coils to revolve on the rod, as the hole in the block is above the centre of the coil. The coils are still essentially air-core coils—a great advantage over solid cores. The advantages and ease of operation of this mounting will be readily appreciated.

The secondary circuit is tuned on a novel principle which the writer picked as being most satisfactory in every way. Bearing in mind that the vacuum valve requires a low maximum secondary capacity—an almost zero minimum—and a fine adjustment of capacity for best results, and that the portable set requires a small weight and bulk, the reader will realize the tremendous advantages of this method. A home-made variable condenser having one rotary and two stationary plates, and a six-step adjustable fixed condenser are used, connected in parallel. The variable is calculated to have a maximum capacity of approximately .000065 mfd., and each step of the fixed condenser about .00005 mfd., so that the variable laps well over on each step. The step condenser is controlled by an ordinary seven point instrument switch, one of which is left unconnected. By joint use of this switch and the handle of the variable, a continuous range—very finely adjustable—from almost absolute zero to approximately .000365 mfd. is obtained, which is ample for valve use.

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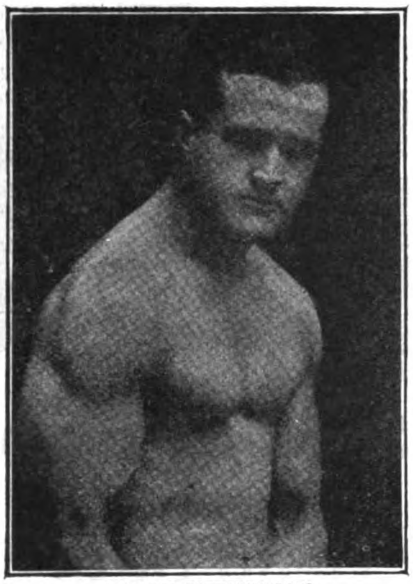

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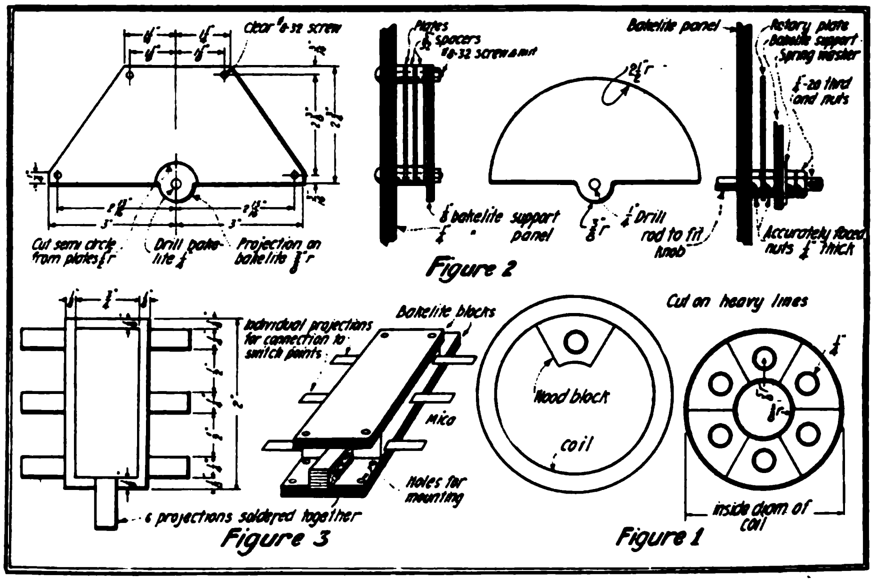

Figures 1, 2, 3.—Constructional details of the portable receiver

small semi-circle being cut out of the lower edge. The same layout suffices for the rear support of the shaft—a piece of ⅛ inch bakelite—except that instead of a cut in the bottom, a projection is left there, and the center of it drilled ¼ inch, as shown. The stationary plates and bakelite support are mounted directly on the back of the main panel of the set. The spacers shown are ⅜ inch in diameter, and exactly 5/32 inch thick. They are drilled in the center to pass an 8-32 machine screw. They had best be made by a machinist, together with two ¼-20 nuts accurately faced to an exact ¼ inch thickness, and a 2½ inch length of ¼ inch brass rod, turned down for a distance of one inch to fit the knob to be used on the condenser and threaded for the remainder of its length with an accurate ¼-20 thread. Figure 2 shows the rotary plate of 1/32 inch aluminum, drilled to fit over the threaded rod, and also a vertical cross section of the shaft and rotary plate as mounted between the panel and the rear bakelite support, all but a small portion of the latter, together with the stationary plates, spacers and screws, being removed for the sake of clarity.

In addition to making the parts, it will be necessary to drill the main panel of the set to pass the turned down end of the rod, and also for the 8-32 screws which support the stationary plates. These screws are slipped into place, and a spacer placed over each. Then one of the stationary plates is slipped on, next another set of spacers, then the second plate, and again a third set of spacers. Now take one of the accurately faced nuts and screw it onto the threaded rod so that it just overlaps the turned down portion by a tiny fraction of an inch. The rotary plate is slipped over the threaded rod up to it, and clamped firmly in place with the second accurate nut. The turned down end of the rod is now placed in its hole in the panel. Now slip the bakelite support over the threaded rod and connecting screws, and place nuts on the latter. The distance from the panel to the bakelite is now 17/32 inches, and since the thickness of the two nuts and rotary plate is the same, these should just fit between the panel and bakelite block. A spring washer is now placed behind the block, and an ordinary ¼-20 nut screwed against it till a slight tension is obtained. This nut is tightened gradually till the rotary plate will stay in any position in which it may be placed, and then a second nut is screwed on behind the first to lock it. The entire assembly as seen from the top is shown in figure 2. The 1/16 inch separation of rotary and stationary plates assures great ruggedness even under hard usage such as a portable set might undergo.

The six-step condenser for the secondary is constructed of mica dielectric, a micrometer being necessary to measure the various thicknesses required. Mica 1 x 2 inches is used, together with a dozen very thin copper plates ¾ x 1¾ inches with projections for connection to switch points, etc. Alternate plates are connected together by soldering the projections, and form one terminal of the condenser, while the intermediate sheets are connected to individual switch points for variation of capacity. It should be understood that only one plate is connected at any one time, it being unnecessary to connect in parrallel.

This admits of an ordinary instrument switch being used instead of a fan switch. To this end the copper plates are spaced as shown, the numbers between them indicating the thickness of the mica in thousandths of an inch, and the numbers at the switch points, the capacity available in microfarads:

10	
10	.0003
12	
12	.00025
15	
15	.0002
20	
20	.00015
30	
30	.0001
30	.00005

Two views of the condenser are shown in figure 3. One is a top view of the mica and copper sheets, showing dimensions, and the other is a perspective view showing the assembly placed between two ⅛ inch bakelite blocks 1 inch wide which are to be clamped together by screws and nuts through the holes shown. The bottom block should be made longer than the top, and extra holes drilled therein for screwing to the bottom of the cabinet. The entire unit had best be baked at about 250 degrees F. for several hours to dispel all moisture, and immediately impregnated with insulating compound, which may afterwards be scraped off where connections are necessary.

The primary is tuned by a purchased balanced-type condenser, capacity .0006 mfd., shunted by a two-step condenser having capacities of .0005 and .001 mfd. This is controlled by an anti-capacity, single-pole, double-throw switch, having a neutral position. The capacity obtainable is therefore continuously variable from the minimum value of the variable condenser to .0016 mfd. The two-step condenser is made of the same size mica and copper and is mounted in the same way as the six-step for the secondary, but only four copper plates are needed spaced as follows:

3	
3	.001
3	.0005

A third condenser of this type is required to shunt the head telephones. This is a six-step condenser made of mica plates 1½ x 2 inches and twelve copper plates 1¼ x 1¾ inches with projections for connections, spaced as follows:

1⅔	
1⅔	.003
3	
3	.0018
5	
5	.001
9	
9	.0006
15	
15	.00035
12½	.0002

While it may be difficult to measure accurately 1 2/3 thousandths of an inch, extreme accuracy is not required in this condenser, owing to its use. The assembly is mounted as before. An eight-point switch is used here, one of the extra points being unconnected, and the other connected so as to short-circuit the "tickler" coil as explained below. The mica for these three condensers should be purchased in sheets 2 x 3 inches, from 1½ to 3½ thousandths of an inch thick, an eighth of a pound of which will be more than sufficient. For the primary and secondary step condensers the mica sheets may be cut in thirds along the three-inch dimension, and for the phone condenser it may be cut in half.

Having described the separate parts which have to be made, attention to the assembly of the instruments is now in order. Figure 4 is a sketch of the front of the receiver, cover removed, and three coils in position. The ¼ inch bakelite panel, 5½ x 13 inches, is mounted flush in the cabinet. The sliding top, 4 x 13 inches, is made to slide in grooves, so that it may be removed for access to the bulb, etc. Dimensions are not given here, but the various parts are marked. The binding posts on the outside of the set will probably be noticed. While they do not appear so well here, this arrangement conserves panel space and permits closing of the cabinet without disconnecting aerial, ground, battery and phone connections. These posts are mounted on

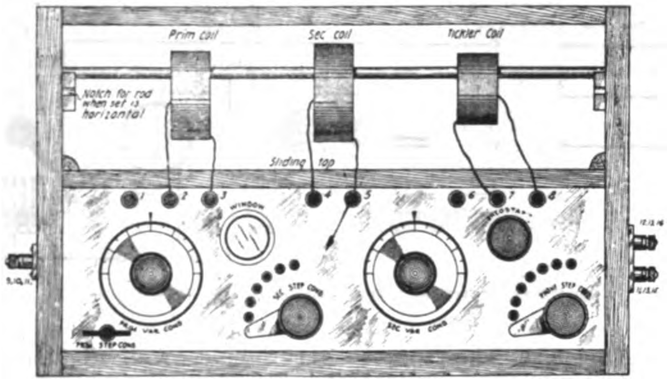

Figure 4.—Front view of receiver with cover removed and three coils in position

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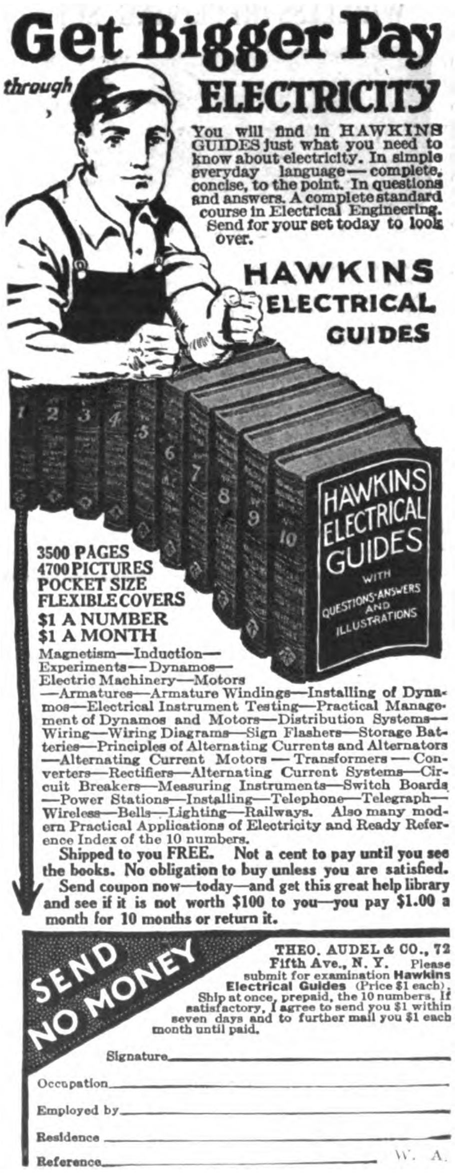
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⅛ inch bakelite, which is screwed over the cut-outs in the side of the cabinet. On the left there are three posts mounted on bakelite 1¼ x 3¼ inch for connection to aerial and ground. On the right are six binding posts mounted on bakelite 2¼ x 3¼ inches, for connection, to "A" and "B" batteries and telephones.

The hole marked "window" is an aperture of 1¼ inch diameter in the panel, through which the vacuum tube is observed. The tube is mounted vertically in a socket which may have to be raised by a block or two of wood, so as to bring the filament opposite the window in the panel. The socket should be mounted as far back as possible so as to leave room for the secondary step condenser in front of it. This condenser, as well as the other two of similar construction, should be screwed to the bottom of the panel through the holes provided. The rheostat, the handle of which is shown on the panel, is a six-ohm instrument of small diameter, and is front mounted on a wooden upright in the back of the cabinet. An extension shaft enables it to be controlled from the front of the panel.

It is here appropriate to mention that since binding posts No. 5 and No. 6 are both to be connected to the stationary plates of the secondary variable, and since they can be placed in just the position of the upper two screws supporting the stationary and bakelite block, the shanks of the binding posts can themselves be used as the supporting screws, saving extra screws and wiring. The writer places the center of his variable 2 9/16 inches above the bottom of the panel, and since the holes in the plates are 2⅝ inches above the center of the variable, the center of the binding posts is brought 5/16 inch from the top of the panel, which is sufficient.

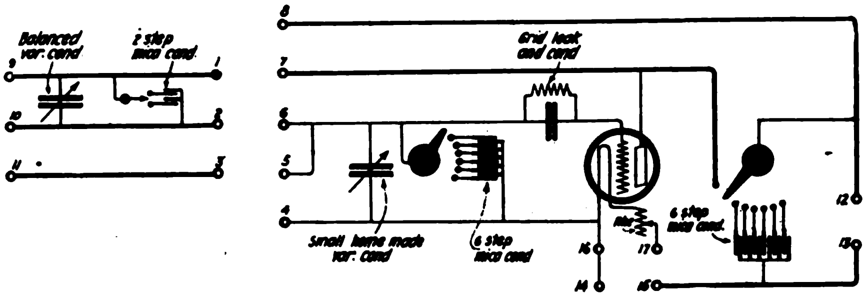

Figure 5.—Theoretical wiring diagram of the receiving set

The wiring of the set will be found very simple, owing to the logical placement of the apparatus. Bare copper wire, over which varnished cambric tubing has been slipped, is best for wiring, although a flexible lead will be required to the shaft of the home-made variable. All connections should be soldered.

The theoretical circuit is shown in figure 5. The aerial is connected to binding post No. 9, and the ground to No. 11. The primary coil is connected between No. 2 and No. 3. The primary condenser is now in series with the coil. A shunt connection may be obtained by connecting No. 10 to the ground without disconnecting No. 11.

The secondary coil is connected be-

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tween No. 4 and No. 5, the "tickler" between No. 7 and No. 8, the telephones to the front two posts on the right—No. 12 and No. 13, the "B" battery to the middle two—No. 14 and 15, and the "A" battery to the back two—No. 16 and 17. To secure regenerative action in the valve, keep the phone condenser switch on any of the first seven points. To secure simple rectification, place the switch on the eighth point, which not only removes capacity from in shunt to the phones, but also short-circuits the "tickler" coil. To use a crystal detector, remove the "tickler" coil, set the detector on the sliding top above the posts No. 6 and No. 8, to which it should be connected, and short circuit posts No. 14 and No. 15. The remarkable flexibility of the set can be appreciated from the foregoing.

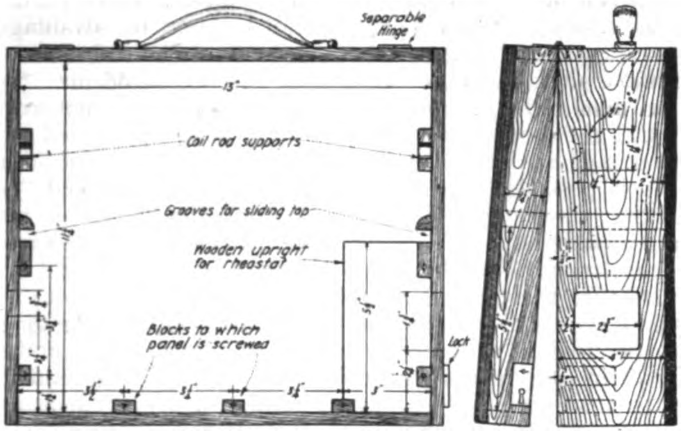

Figure 6.—Details of the cabinet with panel and instruments removed

Figure 6 shows details of the cabinet, panel and instruments removed. This can be made of any wood desired, preferably ⅜ inch. For this reason only the important dimensions are given, and these are inside measurements. The cabinet may be joined in any way desired, but the back must be screwed on only, so as to be readily removable for better access to the interior than can be obtained through the sliding top. The cover is fastened to the cabinet with separable hinges so that it may be removed by opening and sliding to one side. A lock should be fastened on the side of the cabinet near the bottom. A handle should be fastened to the top of the cabinet. The cabinet may be used in the upright or in a horizontal position, two sets of notches being provided for the coil rod as shown. A front view with cover removed, a side view with cover in place, and a top view with cover separate is shown.

When completed this receiver will be found extremely compact. The space in which the coils slide when the receiver is in use forms an excellent storage place for all needed coils, phones, rod, small batteries, etc., when the instrument is being carried, crumpled newspaper being stuffed around

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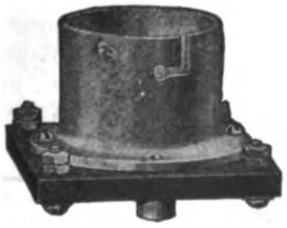

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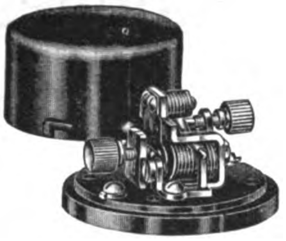

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the articles to prevent them from being shaken around. Thus no space is wasted. In conclusion, the writer would unhesitatingly say that, were he planning a set for stationary use only, it would not differ in any essential particular from this portable one—which shows that he believes the efficiency of the set to be as great as it is possible to attain.

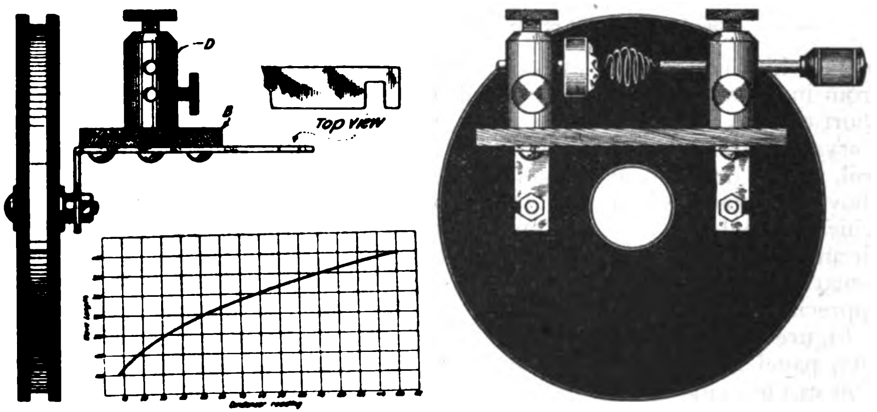
A Simple Wavemeter

By E. P. Hurley

THE majority of radio amateurs and experimenters unfortunately are under the impression that a wavemeter is more or less a luxury rather than a desirable addition to the equipment of a modern radio station. This idea is refuted the moment they have installed and used it, for this instrument makes it possible to accurately determine the wavelength of their transmitting apparatus.

In the construction of the wavemeter, the feature that should appeal strongly to the amateur is that the condenser can be used in other circuits when not used in conjunction with the inductance as a wavemeter. The first requisite is a variable condenser which should be of standard type, having a capacity of approximately .001 mfd. The mounting with the inductance is the only part of the instrument that requires specific description from the builder's standpoint. It is made as shown in figure 1.

The coil is made from a solid piece of ¼ inch bakelite and slotted to the depth of one-half inch to receive the wire. If the amateur does not have the facilities for making a coil of this type, one can easily be made by using two ⅛ inch discs with a center 1 inch in diameter. Hard rubber or formica can be used to advantage, instead of bakelite. The coil is now wound with 22 feet of 23/38 litz. Solid wire can be used if litz is not available. Two small holes are drilled in the coil and the ends of the wire brought through to connection marked "B." The detector support "C" is made from ⅛ inch bakelite. Two supports are made from spring brass and slotted at each end for coil connections and condenser binding posts. Binding posts are mounted on support and cup with rod and detector wire added. Figure 1 shows the arrangement as used by the author. Phone connections are made at "D."



Figures 1, 2.—Construction and graph showing calibration of wavemeter

The wavemeter is now ready for calibration. This can easily be done by comparison with a known wavemeter or for precision work the amateur can send the inductance and condenser, prepaid, to the Bureau of Standards, Washington, D. C., accompanied by a written request for the test, enumerating the articles and advising definitely of the test desired. Fees must accompany all

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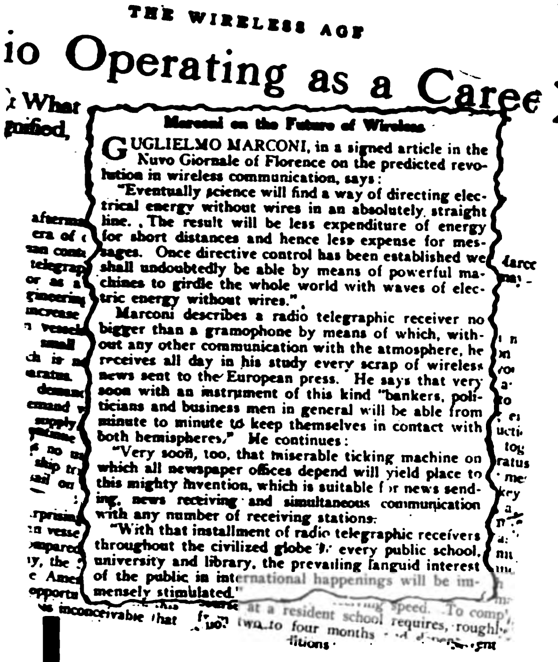

THE WIRELESS AGE

io Operating as a Caree

Marconi on the Future of Wireless

GUGLIELMO MARCONI, in a signed article in the Nuvo Giornale of Florence on the predicted revolution in wireless communication, says:

"Eventually science will find a way of directing electrical energy without wires in an absolutely straight line. The result will be less expenditure of energy for short distances and hence less expense for messages. Once directive control has been established we shall undoubtedly be able by means of powerful machines to girdle the whole world with waves of electric energy without wires."

Marconi describes a radio telegraphic receiver no bigger than a gramophone by means of which, without any other communication with the atmosphere, he receives all day in his study every scrap of wireless news sent to the European press. He says that very soon with an instrument of this kind "bankers, politicians and business men in general will be able from minute to minute to keep themselves in contact with both hemispheres." He continues:

"Very soon, too, that miserable ticking machine on which all newspaper offices depend will yield place to this mighty invention, which is suitable for news sending, news receiving and simultaneous communication with any number of receiving stations.

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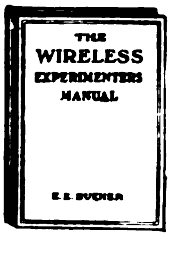

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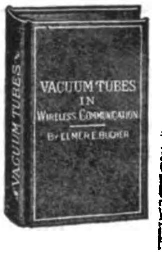
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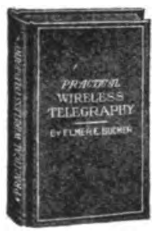

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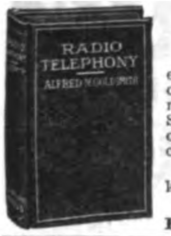

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Prize Contest Announcement

The subject for the new prize contest of our year-round series is:

"SOME POINTERS ON RECONSTRUCTION"

Closing date, August 1, 1920.

Contestants are requested to submit articles at the earliest practicable date.

Prize Winning Articles Will Appear in the October Issue.

No one would care to venture that American amateurs are not observing. Each one of us, during the radio year just gone by, has learned many new applications of this wonderful art which has enabled us to increase the efficiency and the range of our installations. What are these things we have learned and how have they enabled us to increase our range and why? Each of us would like to hear of the other fellow's troubles and how he remedied them. It is in this way that amateur stations as a class will increase in efficiency, and we should all welcome this opportunity to do our bit toward forwarding our mutual interest.

PRIZE CONTEST CONDITIONS—Manuscripts on the subject announced above are judged by the Editors of THE WIRELESS AGE from the viewpoint of the ingeniousness of the idea presented, its practicability and general utility, originality, and clearness in the description. Literary ability is not needed, but neatness in manuscript and drawing is taken into account. Finished drawings are not required, sketches will do. The contest is open to everybody. The closing date is given in the above announcement. THE WIRELESS AGE will award the following prizes: First Prize, $10.00; Second Prize, $5.00; Third Prize, $3.00, *in addition to the regular space rates paid for technical articles.*

All manuscripts should be addressed to the Contest Editor of THE WIRELESS AGE

apparatus and remittances made by money order drawn to the order of the Bureau of Standards. The authority for a specially reduced fee for amateurs is set forth under paragraph No. 7, testing schedule No. 90, and reference should be made to this paragraph when forwarding the wavemeter. The fee is 50 cents per point.

With the condenser used as described above, figure 2 shows the curve for inductance. After the wavemeter has been properly calibrated it can be used for calibration of a receiving circuit by connecting a buzzer battery and switch in series to "D." By coupling the wavemeter coil to the coil to be calibrated, a current will be set up at the point of resonance which can be heard in the telephone of the receiving circuit. By referring to the curve the wavelength can be easily ascertained.

For the calibration of the transmitting circuit, the wavemeter is placed near the transmitter and the condenser handle rotated until the signals are the loudest at which point the condenser reading should be taken and reference made to the curve for wavelength.

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Club to Time Races

THE Radio Club of Burlington (Iowa), organized three months ago, announces that on July 2nd, 3rd, 4th and 5th there is to be a Regatta held at Burlington under the auspices of the Mississippi Valley Power Boat Association. The Radio Club of Burlington has been given the task of timing the races which are to be held on a one mile course between two bridges. The fact that some of the fastest racing boats in the world, such as the Miss Detroit III and others capable of making a speed of almost seventy miles an hour, and because the officials know the speed and accuracy of Radio, the club has been given this important task.

The following is the secretary's brief description of the method which will be employed in timing the races: "We are to have two ½ kw. transmitting stations, together with receiving sets, one at the starting and one at the finishing points of the one-mile course. In order to avoid a possible mistake and to insure accuracy there will be three official timers and two operators at each station, the operators being members of the club. When the fast boats near the starting line a dash will be transmitted from the station located at this line. The ending of this dash will be a signal that the boats have crossed the starting line, and exactly at the ending of this dash the three official timers at both stations will set their stop watches. When the boats cross the finishing line the order of things will just be reversed."

Secretary H. H. Waugh says: "We realize that our task is to be a tedious and painstaking one but nevertheless we intend to put it across in the right manner and we believe that we have the honor of being the first club to try a stunt of this kind. We will also relay friendly messages, announce the winners of the various races, send re-

(Continued on page 42)

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Fifty members of the Irvington Radio Club, Newark, N. J., met at Achtel-Stetter's for the first annual dinner of the organization. The club is nine years old and is said to be the pioneer among societies of its kind.

The speakers were L. M. Clement, of the Western Electric Company, and R. F. Gowan. Both praised the club for its interest in wireless telephony and telegraphy and explained intricate points in apparatus mechanism. Albert Mills, president of the club, was toastmaster. De Witt Paxton entertained with recitations. The club meets regularly Thursday nights at 55 Union avenue, Irvington.

The New Jersey Radio Club was formed at a meeting held in the New Jersey School of Radio-Telegraphy, Elizabeth. There were present about thirty wireless students, from this section of the State, who attend the evening class at the Radio School. It is expected that about ten students of the day class will also join the club. A. V. Hill, of Elizabeth, was elected president, and C. J. Frank, also of Elizabeth, secretary and treasurer.

Meetings will be held every Thursday evening at the school, 218 Broad street, Elizabeth, which is the club's headquarters. A large 1/8 KW Marconi transmitting set with a radius of 350 miles; also a receiving set with a radius 3,000 miles has just been installed in the school.

In the near future a trip to the Fleet Supply Base and Bush Terminal, Brooklyn, will be made under the supervision of Lieut. H. Armerding, U. S. N. R. F., who is the principal at the Radio School. Other trips of this sort are in prospect for the members of the club.

The Camden, N. J., Radio Club was organized about a month ago to assist the amateur in the fascinating study of wireless. It has been decided to erect an antenna on the roof of the Y. M. C. A., and install a set for the members' use. The technical committee has been elected to help any amateur who has difficulty with his set. There is to be a wavemeter for the use of the members, which all amateurs will appreciate. There is to be in connection with the club an apparatus exchange where members may buy or sell any wireless apparatus.

The club has for its president and guide Mr. Knierman, who is at the head of the League Island Radio Testing Laboratory. He is qualified and willing to help the members, so the best thing an amateur can do is to get his friend and go to the Y. M. C. A., room F.

A Loop Transmitter for Local Work

(*Continued from page* 25)

the instrument table as shown in figure 2. The loop should be either of solenoidal or pancake form, the latter being easier to build. It is wound with two turns, spaced 2 inches apart with a conductor whose cross-section is approximately equal to that of the closed circuit conductor. This can be of litzendraht, of lamp cord in parallel, a cable of magnet wire, or of copper strip. Flexible leads connect the loop to the apparatus.

Those interested in the experimental side of loop antennae for transmission should read Scientific Paper No. 354, Bureau of Standards, by J. H. Dellinger, where there is given valuable formulae for calculating distance, received current, etc., using coil antennae. The writer, when working a ½ kw., 500-cycle transmitter of a well-known make, put 8 amps. into the loop described above, when using a .0007 mfd. condenser and optimum coupling. The wavelength was 300 meters. Using a crystal detector, signals were loud at 10 miles. Amateurs within a radius of 15 miles have been worked. The maximum range has not, as yet, been determined.

It is suggested that experimenters should try the loop in a horizontal plane, try to make it uni-directional by combining it with a straight antenna, try enlarging the inductance of the closed circuit, into a loop; in fact, there is no end of experiments one can try when your entire antenna is just above the operating table!

Portable Receiver

(*Continued from page* 29)

Now after the summer season, if the amateur wishes to use this receiver in his home station, the leg fastenings, front cover and handle can be removed and it is ready for station use. The front cover was designed to hold a portable single wire antenna, telephones, high potential battery and tools.

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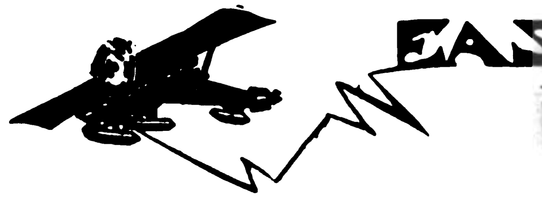

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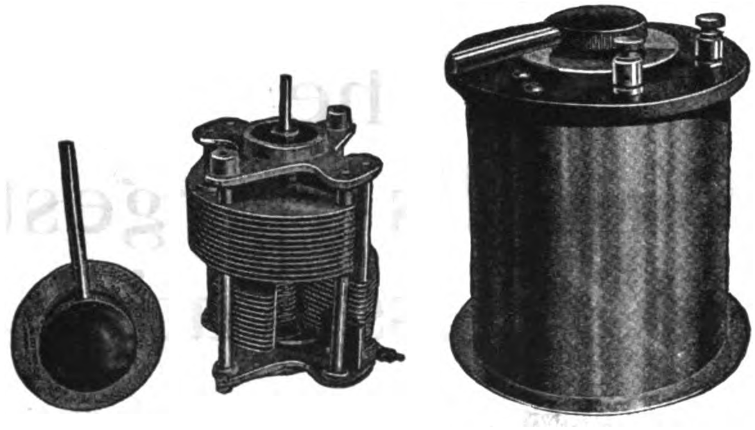

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CONTENTS.
Call Letters of Chief High-Power Stations. Gauges and Types of Wire used in Winding Receiver Coils. Conversion Factors and Data. Typical Valve Circuits. Amateur Station Directory. Receiver Notes. Long Distance Communications, &c., &c. &c.

CONTENTS.
Principal Wireless Stations on Ocean Routes. Table for Calculating Tolls on Messages. Some Typical Valve Circuits. Freak and Long Distance Communications. Best Adjustments of Receiver for Various Wavelengths. &c., &c., &c.

The Wireless Press, Inc. 326 BROADWAY, New York

Tresco Tuners Deliver the Goods
A TESTIMONIAL

TRESCO, Davenport, Iowa, Point Pleasant, N. J.
Gentlemen:—

Some time back you will remember that I bought a 20,000 meter coupler from you and now I wish to tell you of the wonderful results that I have had from it. I was very timid about buying this coupler, as I got stuck with a set of honeycombs, but now I am glad I got that coupler, as I wouldnot part with it for anything.

I could get results with it just as you show the hook-up, but with a little altering I got it to working so that I have heard NPL, BZR, NAR, NFF, NDD, NSS, POZ, OUI, IDO, FL, YN, LCM, and many others that I do not call to mind just at this writing. This is no bull, either; all straight stuff. I am using one bulb—a VT, 3 variables, Baldwin phones, and your Tresco coupler.

Anybody that contemplates buying one of these couplers should not hesitate, as they are the greatest thing out, take it from me. Hoping you are selling lots of these couplers and thanking you for such a wonderful instrument, I am,

Yours very truly,
R. VAN CAMP, Radio Station 2VC.

(*Continued from page 39*)

ports and conduct amateur transmission and reception in general with a powerful 1 kw. transmitting station (Call 9 ACZ) together with a short wave regenerating receiver, long wave set, and a couple steps of amplification."

Queries Answered

Answers will be given in this department to questions of subscribers, covering the full range of wireless subjects, but only those which relate to the technical phases of the art and which are of general interest to readers will be published here. The subscriber's name and address must be given in all letters and only one side of the paper written on; where diagrams are necessary they must be on a separate sheet and drawn with India ink. Not more than five questions of one reader can be answered in the same issue. To receive attention these rules must be rigidly observed.

Positively no questions answered by mail.

J. F. T., Kingsbridge, N. Y. C.:

In order to get the 25-mile radius with the radiophone outfit which you mention, it would be necessary for you to use a 400-volt generator. A 60-volt B battery would probably reduce your radius to something like 3 or 4 miles.

* * *

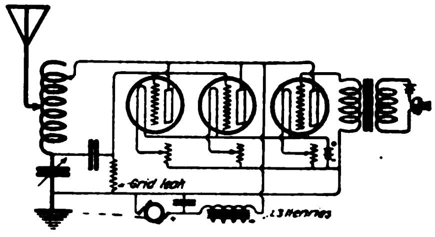
W. F., Troy, Ala.:

We gather from your letter that you are unable to receive signals on either of your two aerials and blame this to lack of a good ground connection. If you have a connection soldered to the city water system and the rest of your apparatus is in the proper shape, you should get some indication of signals. A connection to the water system is, however, not always the best ground possible. If you are so located as to be in a position to erect a counterpoise, we would suggest that you do this. A counterpoise provides an antenna system of high efficiency, regardless of local terrian conditions.

* * *

E. N. W., New York City:

We print herewith your corrected diagram covering connections for three vacuum tubes and a radio telephone outfit.



You will probably be able to buy a 2,000 volt D.C. generator from the Electric Specialty Company, Stamford, Conn.

The fundamental wavelength of your antenna is approximately 243 meters.

* * *

F. H. M., Albany N. Y.:

The following formula will enable you to find the required condenser capacity for a radio transformer:

$$C = \frac{2W}{E^2N \times 10^{-6}}$$

where C is in farads
W in watts
and N the spark frequency

* * *

J. J. A., Washington, D. C.:

It would be impossible for us to give you instructions covering the construction of a wavemeter having a range of 150 to 12,000 meters in these columns. Various articles have been printed from time to time within the last few months covering wavemeter construction. You should be able to get sufficient information from these to enable you to build such an instrument.

J. G., Tranquille, British Columbia:

Although the use of 110 volts D.C. is not to be recommended in case you are expecting to use an amplifier in conjunction with your detector, it can be done. A circuit of this sort was published in a recent issue.

In case you have only two tubes, it would be better for you to use the second as an audio frequency amplifier, rather than a radio frequency amplifier.

Marconi "Q" and "V24" valves are manufactured by the British Marconi Company. "VT1" and "VT2" valves are marketed by the Marconi Company and are identical with the Audions sold by the De Forest Company. The amplification factor of the "VT's" is about 7 to 1. We regret that we have no data available, giving the characteristics of the tubes manufactured by the British Company, but we presume that they are at least equal to the product of the American Company.

* * *

F. A. W., Woodhaven, N. Y.:

In a recent issue we published a correction covering the circuit diagram shown on page 15 of the April issue. The penciled corrections which you have made on enclosed drawing are O. K.

* * *

J. C., Jr., San Jose, Cal.:

The fundamental wavelength of your antenna is approximately 225 meters. In case your antenna terminates on one end at the house in which your radio set is located, it would be impracticable to attempt the conversion of your L antenna into a T antenna. The lead-in from the T antenna should be as nearly vertical as possible. We suggest that you cut off twenty (20) feet of the end of your antenna.

In the June issue of WIRELESS AGE, several wavemeters were described, together with information which will enable you to construct one for short waves.

* * *

W. S., Port Williams, Nova Scotia:

In the construction of your two-stage audio frequency amplifier, you will find that the best and most convenient method for securing the correct negative grid potential will be by bringing the filament side of the transformer secondary to the slider of your rheostat and connecting the rheostat slider to the negative terminal of the six-volt filament lighting battery. Under these circumstances, in case Marconi "VT's" are used, a resistance of about two ohms will always be in circuit between the filament connection of the transformer and the filament itself.

If we have two oscillatory circuits inductively coupled, any change of coupling between the two circuits will change the wavelength of both circuits, due to their mutual inductance. The fact that the note of a received undamped signal changes when you vary the coupling in your receiving transformer is due to this effect and only in a minor degree to a variation of capacity in either of the two circuits.

We very much regret that we are unable to tell you at the present time what stations have been assigned the calls PTA, NSN, VAV, and WBF. We will endeavor to secure this information for print at a later date.

* * *

H. M., Newport News, Va.:

We regret that we have no actual construction of details covering the uni-control receiver invented by Roy E. Thompson. It is to be presumed, however, that the size of wire and the insulation is of slight import. If you are considering the construction of such an instrument, we suggest the use of No. 24 double cotton covered, or a No. 20/38 Litzendraht 'double silk covered.

No Seals - No Secrets - *But Service!*
There's only one Relay Receiver the
GREBE RADIO
TYPE CR-3
Relay Receiver

Inspection of the interior of this Receiver reveals design and workmanship fully in keeping with its outward appearance.

The circuits used are thoroughly explained in the instructions and blue prints which accompany each Receiver.

The use of this Receiver is licensed under the original Armstrong and Marconi patents.

The GREBE RADIO guarantee is absolute and unconditional. Each instrument manufactured by us must give satisfactory service. Our interest in the purchaser does not terminate with the sale.

The CR-3 Receiver may be inspected at any of the following progressive dealers:
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Continental Radio and Electric Corp. New York
Doubleday-Hill Electric Co., Pittsburgh, Pa.
Holt Electric Utilities Co., Jacksonville, Fla.
Hurlburt-Still Electrical Co., Houston, Texas
Kelly and Phillips, Brooklyn, N. Y.
Manhattan Electrical Supply Co., New York, Chicago, St Louis
Pacent Electric Co., Inc., New York City
Geo. W. Parsons & Co., Washington, D. C.
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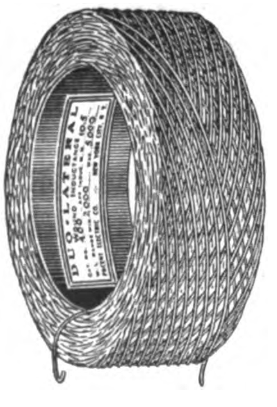

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Single Phase Motors
110-220 volts, A. C., 60 cycle, 1800 R. P. M. with pulley

1/4	H. P., 110 volts, induction, full load start - -	$28.50
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Suitable for all lighting, Battery Charging and Power Requirements.

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2 and 3 phase, A. C., 220 v. 60 c., 1750 R.P.M., complete with base and pulley.

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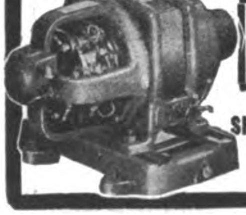

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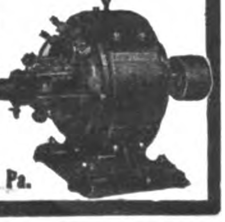

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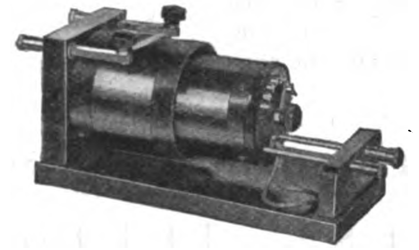

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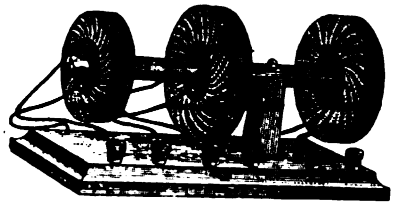

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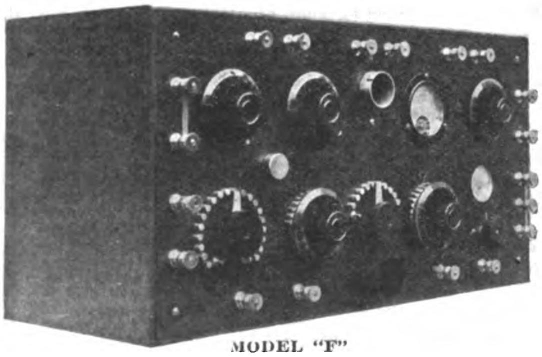

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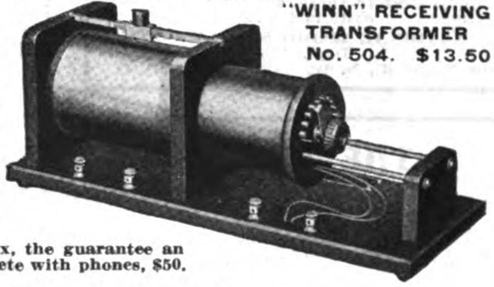

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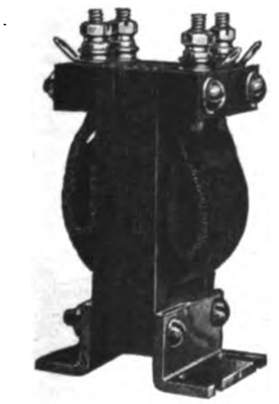

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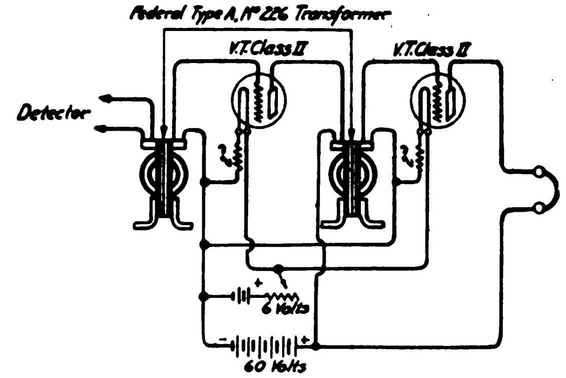

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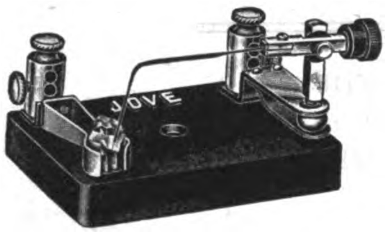

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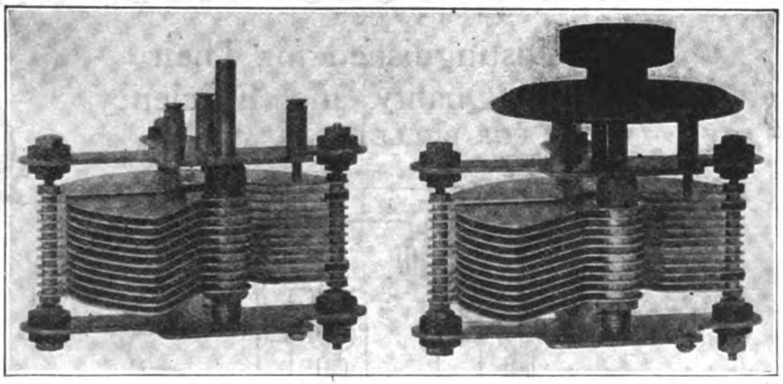

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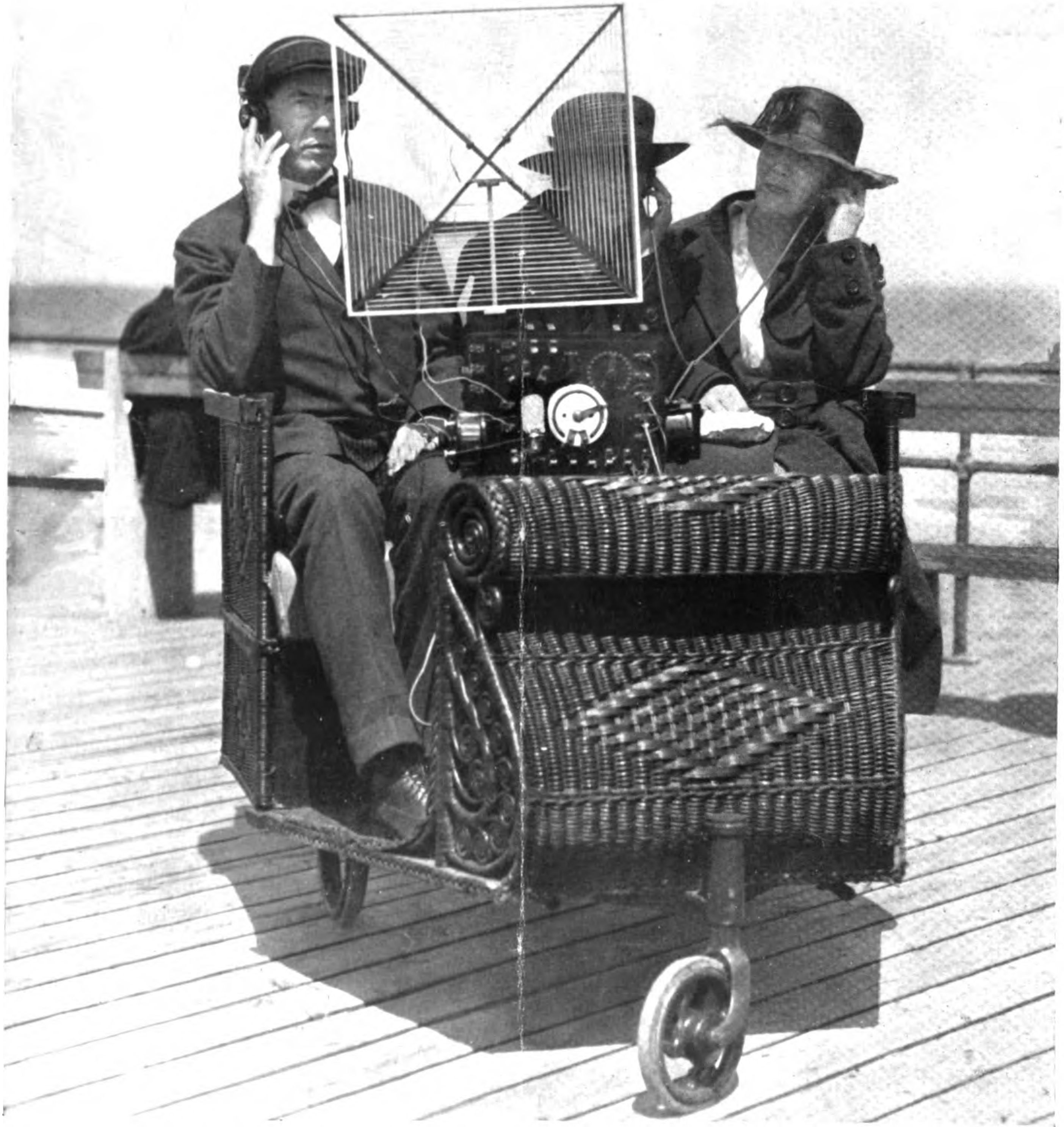

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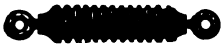
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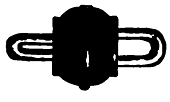
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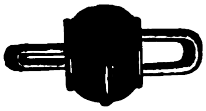
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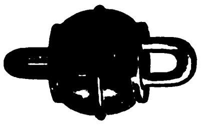
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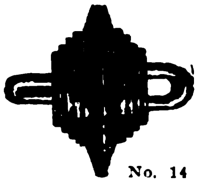
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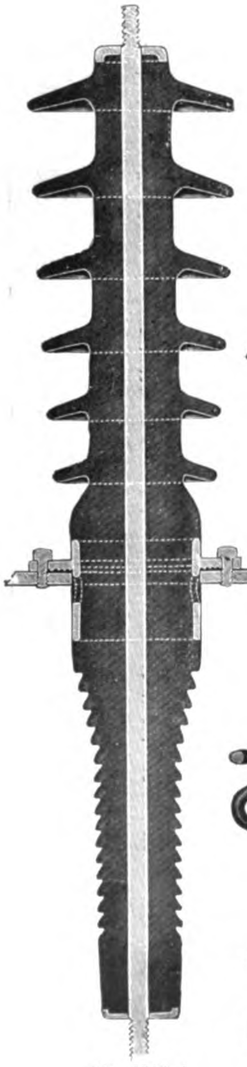
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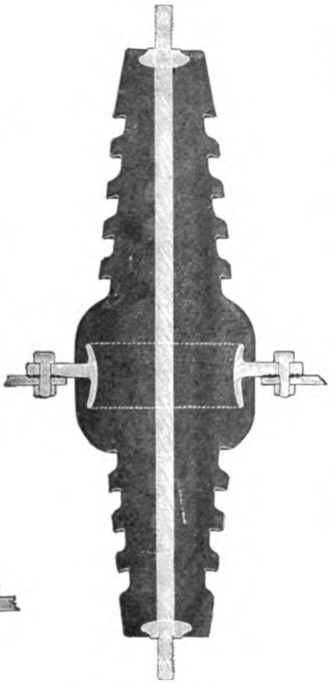
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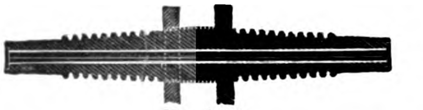
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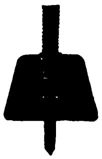
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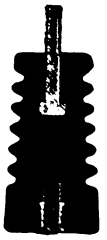
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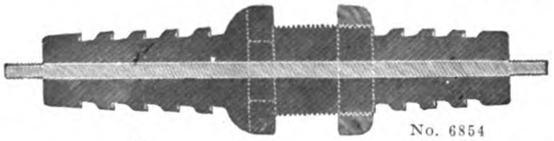
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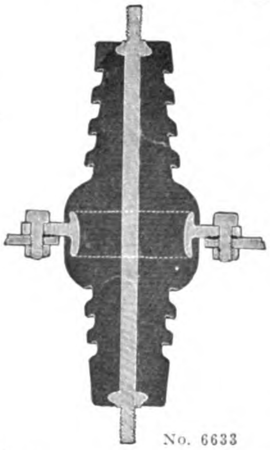
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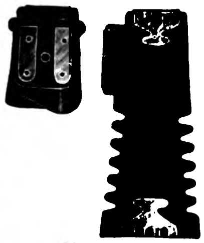
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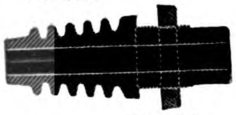
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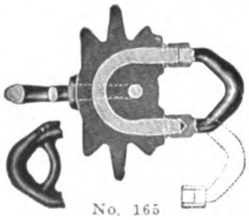
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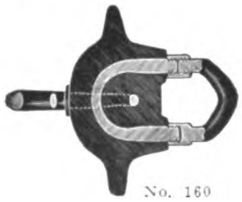
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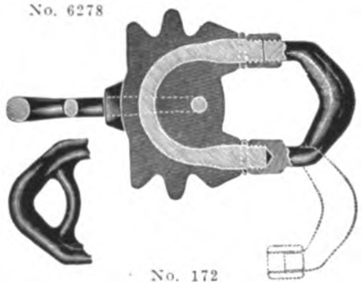
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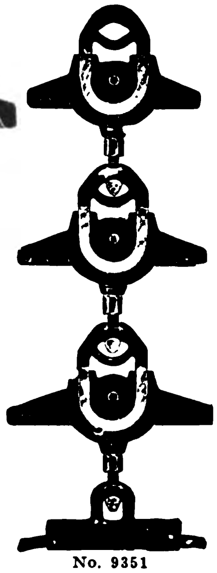
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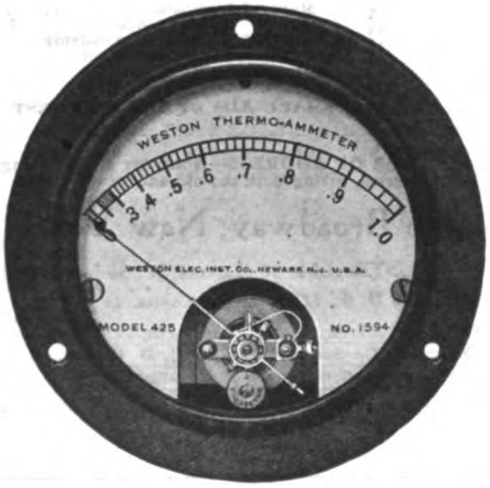

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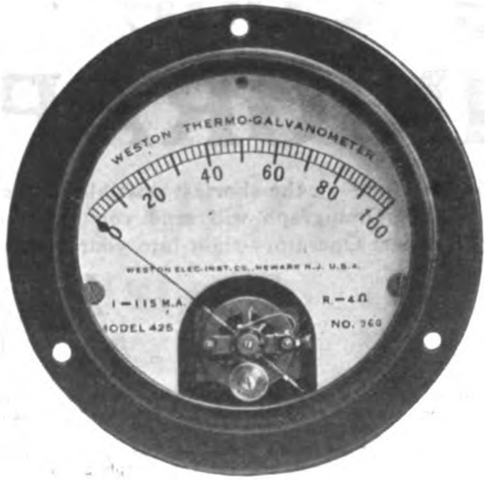
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Edited by J. ANDREW WHITE

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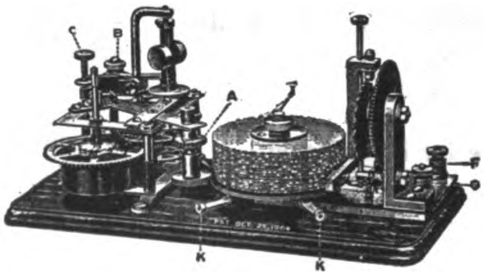

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International TXL-100A	$16.75
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ANTENNA SWITCHES

463	Murdock, switch stands up to 1K.W.	$4.50
F658	Clapp Eastham, three pole with bakelite antenna post	12.50

AMPLIFIERS

RORE	Grebe single step audio frequency amplifier	$23.00
RORJ	Grebe 2 step amplifier with com switch control	45.00
RORG	Grebe detector and one step amplifier	43.00
RORD	Grebe detector and two step amplifier	65.00
	Radio Craft Co. two step amplifier	50.00
	Radio Craft Co. detector and two step amplifier	70.00
P200	DeForest two step amplifier with "B" battery	70.50

BUZZERS

55	Mesco Buzzer	$2.25
	Century Buzzer	2.25
251	Nickelplated	0.80

CONDENSERS

	General Radio 182H	$12.00
C.V	500 DeForest	6.25
366	Murdock	4.75
367	Murdock	4.75
368	Murdock	3.75
F800	Clapp Eastham	7.50
F800A	Clapp Eastham	9.50

SOCKETS

156	General Radio	$1.75
550	Murdock	1.00
	Radio Service	1.20
R300	DeForest	1.50

HOT WIRE AMMETERS

General Radio No. 128 0-1 or 0-2½ Amperes	$5.00
Roller Smith 0-2½ Amperes	7.00
Extra shunts	.75

"B" BATTERIES

766	Am. Eveready 22½ V 10 Amp.	$3.50
7623	Standard 22½ V "B" Batteries, Variable	1.35
7625		2.40
7650		3.25
9280	Cyclone 22½ Volts. 5 amp.	1.00
9281	10 Amp.	2.00

UNMOUNTED VARIOMETERS

150 to 600 meters all assembled, ready to mount on panel	$4.75
150 to 800 meters	5.75

AMPLIFYING TRANSFORMERS

Acme—specially mounted	~~$5.00~~
Acme unmounted	4.50
~~Federal 226w~~	~~7.50~~

DUO LATERAL COILS

U S	25	$ .90
	35	1.00
	50	1.10
	75	1.20
	100	1.30
	150	1.40
	200	1.50
	250	1.60
	300	1.80
	400	2.00
	500	2.20
	600	2.50
	750	2.70
	1000	2.90
	1250	3.50
	1500	4.00

HONEYCOMB COILS

L25	$1.40	150	1.80	600	2.65
35	1.45	200	1.90	750	2.80
50	1.52	250	2.00	1000	3.00
75	1.60	300	2.10	1250	3.35
100	1.70	400	2.25	1500	3.60
		500	2.40		

Instruments and parts listed above will be sent postpaid to any part of the United States.

Our word of honor to you is our guarantee. Let us prove it.

CONTINENTAL RADIO AND ELECTRIC CORP.

J. DI BLASI, Secretary

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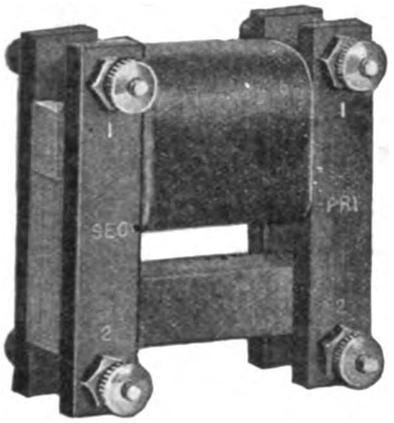
DEPT. E5, 6 WARREN STREET, NEW YORK

RADIO PROGRESS



Progress in Radio means the efficient elimination of unnecessary, old and inefficient apparatus and in producing instruments full of life and vigor, quality, workmanship and service; something necessary to the modern station of today; something that is an improvement over the old methods: —the

A. R. Co. Amplifying Transformer

is distinctly a step forward, a step towards the goal of efficiency. In designing this piece of apparatus, particular reference was given to the correct ratio of impedance and turns between primary and secondary.

Another feature which makes this transformer a desirable piece of apparatus, is the simple but very effective mounting of bakelite strips, supporting the laminated closed core and coil, which allows for quick mounting in case or on panel.

The primary and secondary leads are indicated by engraving on the bakelite mounting strips.

The price does not do justice to the reliability and high service quality of this product.

A-4 Amplifying Transformer, list price $5.00

does not include carrying charges on one pound or duty paid for use in Canada.

RADISCO AGENTS carry only apparatus of proven merit. Look for the Radisco trade mark on all parts you buy and be sure of getting efficient apparatus.

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BALTIMORE, MD.
Radio Engineering Co.,
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BEINVILLE, QUEBEC, CAN.
Canadian Radio Mfg. Co.

BOSTON, MASS.
Atlantic Radio Co.,
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BROOKLYN, N. Y.
Kelly & Phillips Electric Co.,
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BRONX, NEW YORK
Amateur Wireless Equipment Co.,
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CHICAGO, ILL.
Chicago Radio Laboratories,
1316 Carmen Ave.

EUREKA, PEORIA, ILLINOIS
Klaus Radio Co.

KANSAS CITY, MO.
McCreary Radio Supply,
4th & Delaware Sts.

LOS ANGELES, CALIF.
The Wireless Shop,
511 W. Washington St.

MONTREAL, CAN.
J. B. Miller,
1600 Hutchison St.

McKEESPORT, PA.
K. & L. Electric Co.,
427 Olive Street.

NEW ORLEANS, LA.
L. A. Rose,
121 Camp Street

NEWARK, N. J.
A. H. Corwin & Co.,
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NEWCASTLE, PA.
Pennsylvania Wireless Mfg. Co.,
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PHILADELPHIA, PA.
Philadelphia School of Wireless Telegraphy,
Broad and Cherry Streets.

PROVIDENCE, R. I.
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A MORE COMPREHENSIVE WICONY SERVICE

The Radio Art has long known WICONY to stand for perfection as applied to Navy, Army and Commercial Radio Apparatus.

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Radio dealers, amateurs and experimenters have been freely consulted. Therefore, the new service is really yours--prepared by men who would consider the matter from YOUR point of view.

If, at any time, you can help us improve WICONY service by suggestions, or otherwise, please let us hear from you.

Sincerely yours,
WIRELESS IMPROVEMENT CO.

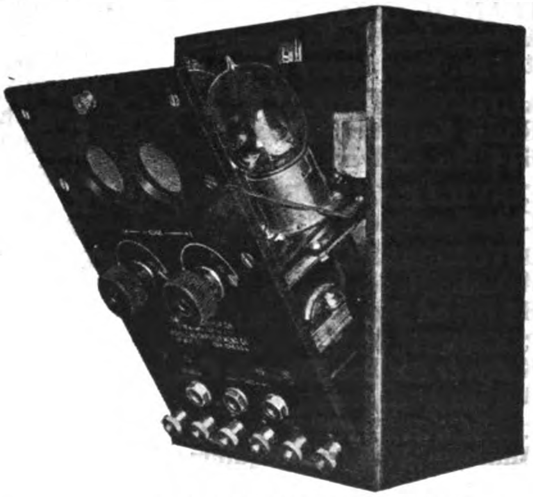
NEW TWO-STAGE AMPLIFIER

So designed that the telephones can be plugged into any one of three jacks to obtain, (1) the input signal strength, (2) amplification from one vacuum tube, or (3) total amplification, from both tubes.

With total amplification, unusually strong signals are obtained from formerly weak signals. This amplifier was specially designed for the Marconi-Moorehead-De Forest tubes but it is very efficient for all types.

Fully described in bulletin 6A.

Two stage audio frequency amplifier Type WI 165 A. Over all dimensions H. 9¾ in. W. 6¾ in. D. 4⅞in. Shipping weight 7 lbs. Price $69.00



NOTE: The panel of our new instruments are hinged at the base. No marred panels or worn screws. Panel removed in 10 seconds.

BULLETINS: Ask to be put on our bulletin mailing list. A small fee of 10 cents is charged to assure us of your serious interest.

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WIRELESS IMPROVEMENT COMPANY, Inc.

Radio Engineers and Manufacturers

47A West Street **New York, U. S. A.**

If this page is cut out and appended to the same page cut from the editions to follow, a complete file of very interesting information will soon be available. (No. 8)

Vol. 7. No. 11. August, 1920

THE WIRELESS AGE

WORLD WIDE WIRELESS

Television, a New Radio Development

FROM England comes announcement of two developments in wireless transmission, both picturesque, one indeed bordering upon the realm of the fantastic and marvellous. H. Grinnell Matthews, an English experimenter, avers that he has made encouraging progress with a "television" device which will make it possible to witness, almost instantaneously, events that are actually happening far away.

He also announces that he has successfully photographed sound waves and reproduced them from the photographs with the aid of electricity. This would make possible a practical "talking movie."

However, the television announcement was skeptically received by some American wireless experts. Dr. Alfred N. Goldsmith, secretary of the Institute of Radio Engineers, doubts whether this wonder is to come to pass.

"If an entirely new principle of sound and light transmission has been discovered," said Dr. Goldsmith, "it is possible that the scheme will be successful; but from the data at hand I should judge that these discoveries are not much more than the annual rediscoveries which are so common in radio work.

"Every little while some amateur 'discovers' something strange and marvellous in radio work—only to find that he has 'discovered' a fact already familiar to research workers. Therefore, unless something revolutionary in science has been unearthed in England, there probably is nothing new in these devices."

Dr. Goldsmith added that the transmission of images over long distances was not only possible, but that fairly successful experiments had been made with the process. The basis of image transmission is selenium, an element not unlike sulphur. Selenium, in the dark, is an insulator; but when light is thrown on it, it permits an electric current to pass through.

Radio Does Double Duty in Sky Piloting

SERMONS are being sent through the sky in Kansas now. Dr. Clayton B. Wells, a minister at Wichita, Kan., has his sermons sent broadcast every evening by a member of his congregation who has an amateur station at his home.

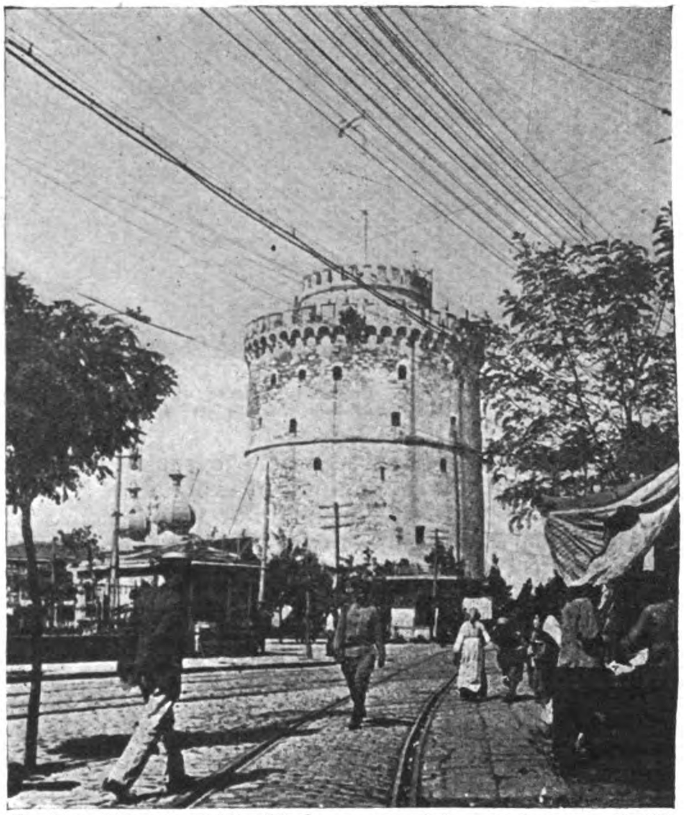
The idea occurred to C. A. Stanley, of Wichita, after sending out a "QST" one Sunday night as to how many station operators had attended church service that day. Of the 300 in his territory very few attended. He wirelessed them, inquiring if they would care to take the sermon every Sunday night.

From the cow country of the Texas Panhandle, the mountains of Colorado and the rural sections of Iowa came back a request to shoot out the sermons. Stanley proceeded to shoot and he has been sending out the sermons for several weeks. He attends the morning service and takes note of the sermon. The sermons are wirelessed between 7 and 7:30 o'clock in the evening.

Argentina Plans Elaborate Commercial Radio Service

RADIO service in Argentina is soon to be augmented and devoted to commercial uses, it is announced. The installations at present in use are employed mostly for Government despatches.

Radio stations are to be set up at the Patagonian ports of Gayman, Rawson and Puerto Gallegos and one at Buenos Aires. It is intended later to supplement them with others at Corrientes, Bahia Blanca, Comodoro, Rivadavia and Ushuaia. Stations already existing will be increased in power.



"La Tour Blanche" of Saloniki, Greece, one of the most important British wireless stations during the war. (See description on page 8)

Night Landing of Mail Plane by Means of Radio

WIRELESS calls for aid sent out by a government mail airplane which faced a descent in the dark, enabled the plane to make a safe landing. Delayed an hour by a wind storm on the last lap of a journey from New York to Chicago, the radio operator on the plane sent out calls while approaching Chicago to light the landing field and prepare for the machine's descent.

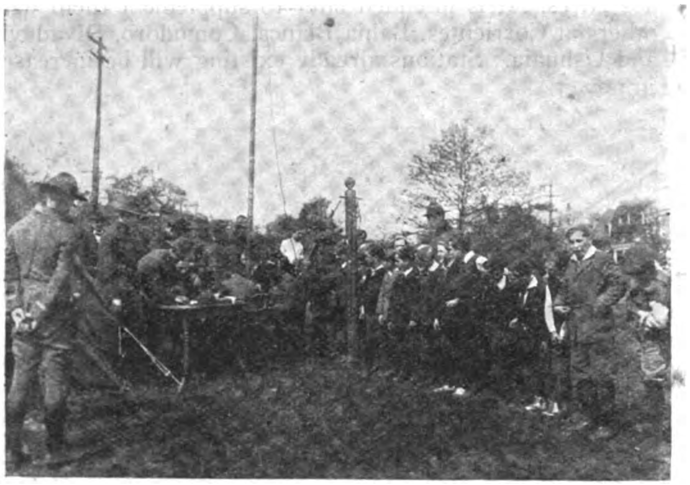
The message was picked up by the wireless operator at Great Lakes Naval Training Station and on several amateur wireless outfits and relayed to the landing field by telephone. The plane, which carried three passengers and 1,200 pounds of mail, landed at eight o'clock.

Radio Messages Sent From Old Tower That Once Served as Prison of Torture

ON the top of the "Tour Blanche"—the notorious "Bloody Tower" of Saloniki, Greece—the British erected a wireless station that enabled them to keep in touch with their ships in the Mediterranean and Aegean Seas. This was one of the most important of Allied "talking-points," which were spread over the earth's surface, and its messages, relayed to all posts of the Western World, played an important part in the final victory of the Allies.

This tower of stone has lived through a long and colorful history. Centuries ago it was built by the Turks, and it is said that it was used as a house of torture and execution for political prisoners. Under the Turkish régime in the Near East many Christians of European countries are supposed to have perished in this tower.

Saloniki, situated at the head of the gulf of the same name, is second only to Constantinople as a seaport. It has a spacious harbor—opened in 1901—where the imports for Macedonia, Albania and Serbia are received. Exports from this port consisted chiefly of grain, flour, chrome, manganese, hides and tobacco. In recent years these countries have been so depleted of men and products that they have not been able to supply their own industrial wants, to say nothing of exportation.



Underwood

Members of the New York University reserve officers training corps operating a field wireless set

Prior to the Turkish Revolution of 1908, Saloniki was the headquarters for the Young Turks. The city surrendered to the Greeks in the Balkan War, November, 1912, and is now a part of Greater Greece. Its present population, mainly Jews, is estimated at 174,000.

The strategic importance of Saloniki cannot be overestimated, and was one reason for the location of the British Wireless Station at this point. During normal times, it possesses railway connections with Constantinople, Vienna, and Paris, besides Nish, Uskub, and Monastir, in Serbia.

Given a strong wireless station to supplement its shipping and harbor facilities, it became a port of real naval value. From their keys in the old stone tower overlooking the waters of the Aegean, these British wireless operators could talk to their commanders and comrades all over the Near East. Strong radio stations were maintained by the British on the Island of Modros, at the entrance of the Dardanelles, on Lemnos, at Suda Bay in Crete, and on Malta. From these wireless posts, many instructions were issued to the British submarines, which had their base at Mitylene.

During the Allied occupation of the city, the old Turkish citadel became the headquarters for the press and censorship bureaus and the base headquarters for the American Red Cross. Many tons of food, clothes, and medicines were unloaded from the ships anchored at its docks, and transported by slow train, motor car, and pack-mule to the remote districts, whose people were hungry, sick and naked. The work of Red Cross doctors and nurses has improved the conditions of sanitation and health throughout the Balkans, and saved many lives.

French Scientist Predicts Synchronized "Voice-Movies" by Means of Radio

OUT of the void into every moving picture theatre, synchronized with all the movements shown on the film, will come in the near future the voices of the actors as they play their parts. Such is the dream of Professor Edouard Branly, expert on wireless telephony.

The success of the concert given by Mme. Melba at Chelmsford, England, to all the wireless telephone listeners in London, Paris, Berlin, Rome and Christiania, is his text. Soon, he declares, everyone will be able to stay at home and hear any concert he wishes, and for all the movies one orchestra will be sufficient.

He even goes further. Groups of motion picture theatres, he declares, will throw the same film on the screen at the same instant, while the actors will speak their parts into wireless telephone instruments thus securing the synchronization which is impossible with the talking machine, and in the days to come the movies will become the serious rivals of the theatre.

The only difficulty foreseen seems to be the breaking of the film while the voices go on without action.

Sweden Adopts Radiophone to Aid Fishing Industry

WIRELESS telephone receivers are being placed by the Swedish Government on fishing craft, so the fishers may be warned of bad weather and informed where good catches of herring may be expected. As no transmitters will be placed on the boats the fishers will not be able to communicate with other vessels nor with wireless stations on shore.

Marconi's Wireless Telegraph Company of London Declares Dividend

THE Radio Corporation of America, which recently succeeded the Marconi Wireless Telegraph Company, has received information from London that the Marconi Wireless Telegraph Company, Limited, the British company, had earned a profit of £1,220,000 in 1919, including £590,000 damages from the British Government. Directors of the British Company have declared a final dividend of 15 per cent. on ordinary and preference shares, together with a bonus of 5 shillings per share. New shares issued last December to former stockholders do not participate in the dividend and bonus. The statement showed that £955,000 was carried forward to surplus.

French Conducting Radio Research in the Pacific

VALUABLE experiments in wireless telegraphy are being conducted by the French war sloop Aldebaran, which has been cruising in the Pacific near the Chatham and Bounty Islands. Lieutenant Guierre, wireless expert, will probably submit the result of his experiments to the international wireless conference in Washington shortly. He states that the wireless "reception" in New Zealand from French instruments is of special interest to continental experts, as New Zealand is practically the antipode of France. It is claimed that the Aldebaran is carrying out for the first time a truly comprehensive system of measuring the strength of "receptions."

Submarine Wireless Perfected

THE last annual report of the Bureau of Standards states that members of the bureau's staff have developed very successful methods of communicating with submerged submarines by radio-telegraphy. With a single-turn coil or loop attached to the outside of the submarine, signals can be received as well when the vessel is submerged as when it is at the surface. It is also possible to transmit from a submerged submarine a distance of twelve miles. Thus it becomes possible for a ship and a submarine to exchange recognition signals.

A coil aerial is a satisfactory direction finder when submerged and readily receives signals transmitted thousands of miles, just the same as when used in the air. The navy has equipped its larger submarines with this apparatus.

Mother of Marconi Dies

MRS Marconi, mother of Guglielmo Marconi, the inventor, died June 15. She was an Irish woman and the widow of Giuseppe Marconi, of Bologna.

France Plans Extensive Wireless Service

THE success of the French Government's wireless service between the Continent and Algiers is assured. The Ministry of Telegraphs is preparing a scheme for the extension of the wireless service which will involve the erection of several stations and the inauguration of commercial as well as official wireless service between France and America, Germany, Italy and Constantinople. It is proposed also to erect stations in important French cities, thereby relieving the pressure of the land wires, and if the Government provides for it in the budget the French colonies and island possessions are to be linked up by wireless next year.

The first wireless extension to be attempted was communication with the United States, messages being sent from a station near Lyons and received by United States naval stations, where they are transferred to the telegraph lines. This service has been used for the last few months by several American newspapers.

Radio Banking Service on the High Seas

WIRELESS banking is a success aboard the ex-German liner Imperator. The Cunarder has established the first sea bank with a safe large enough to carry a huge amount of ready cash. Drafts on shore banks are honored and money transferred by radio.

Results of Marconi's Recent Radio Cruise

SIGNOR MARCONI, the wireless expert, has improved the wireless compass, according to the London Daily Mail, which will emit wireless warnings in a fog and by the aid of it he can tell which is on the port and which is on the starboard side of a vessel. The Mail's correspondent at Rome quotes him as follows with reference to his recent cruise in the Electra in search of new data to be used in the development of wireless:

"We steered the yacht the whole way," he said, "by the use of a wireless direction finder and kept away from the rocks off Cape Finisterre, northwest Spain, exclusively by its use. Most of the time we were able to locate our position by magnetic intersections on land stations.

"We made one fairly important discovery. I have evolved an improved wireless compass by which I can tell which is the port (left) and which is the starboard (right) side of a ship. It will emit wireless warnings instead of fogblasts." Senator Marconi went on:

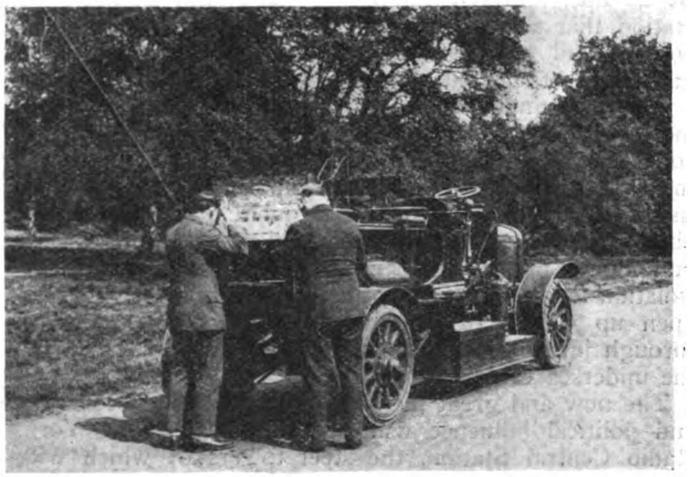
"I kept in touch with England for a time by wireless telephone, our instrument having a radius of 450 miles. I also conducted business by the same means between Seville and Lisbon.

"We had great fun on the way out, having musical evenings with Chelmsford, Essex. They put on the latest tunes on the gramophone at Chelmsford and we heard them plainly. We applauded and they thanked us.

"The wireless telephone worked splendidly throughout and was clearer than a land telephone.

"My cruise is only half finished. The yacht is at Spezia and I intend to return to England in her in about a fortnight. The voyage should result in several improvements and new inventions being patented."

Senator Marconi naturally is inclined to be reticent on this subject, but he gave the impression that he will shortly announce the perfecting of the existing wireless direction-finding gear, enabling ships to steer clear of one another by this means alone in thick weather. Also that, although the day when ships may dispense with the use of lighthouses is not yet, vessels may soon be able by simple wireless means to avoid rocks as Senator Marconi did. Senator Marconi is also probing the origin of atmospheric or electric storms and how to combat them. He encountered one when he was off Algiers.



Underwood

Firemen operating a wireless telephone installed on rear of fire tender

Manitoba to Use Radiophone

EXPERIMENTS conducted at the request of the Manitoba government with wireless telephone apparatus between Winnipeg and Portage la Prairie, 80 miles away, have been successfully concluded and a second step in the experiments is about to be taken, when conversations will be attempted between Winnipeg and Ft. William, a distance of nearly 400 miles. The experiments are being taken with a view to testing out a proposed system of wireless to be installed in northern Manitoba.

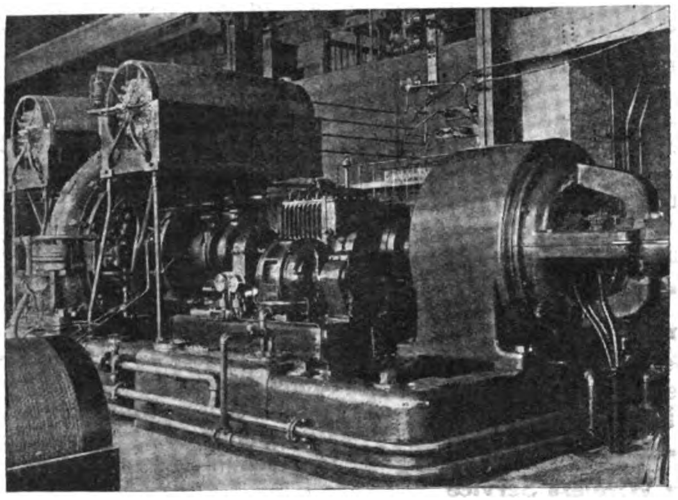
Mining districts and fur marketing centers are far scattered and sparsely settled. Land wires are costly to install and to maintain owing to falling trees in the bush country. It is proposed to establish some dozen stations at central points in as many districts of the northland, and these will in turn be given communication with the outside by a station of larger power at The Pas, which will work with another similar station at Swan River, 250 miles south of the former place, and in the well settled portion of the Province.

Should wireless telephony prove successful it is probable that the Manitoba government will assume control over this form of communication, just as it has the telephones, and that the wireless will be incorporated in the government telephone system. In this way the government may be able to give service to many isolated points, notably in mining sections east of Lake Winnipeg which cannot now be reached by land wires.

New York Radio Central Station

Details of a Super-powered Radio Station to be Erected Near New York for Communication with Five Nations

FOR more than two decades the wonders of wireless have so unceasingly intrigued the public imagination that it would appear little remained to be accomplished in developments of revolutionary character. Yet, once again, it is disclosed that a startling conception in wireless communication has been quietly brought to a point of realization. On the north shore of Long Island, near New York, the Radio Corporation of America is about to begin construction of a super-powered radio station that will simultaneously send to and receive messages from five great nations of other continents.



200-Kilowatt Alexanderson Alternator, which is part of the equipment of the Station

The bare announcement presages a new era in commercial radio communication. It is one conceived in the convention-defying spirit which, coupled with engineering skill, has brought about the expansion of wireless to its present status as a world-wide public utility. Instantly obvious is the fact that the plan will result in the contribution of an important means of breaking down America's isolation from the peoples of certain other continents and open up visions of communication possibilities which, through inherent limitations, could never be realized by the undersea cables.

The new and great medium of far-reaching economic and political influence will bear the name New York Radio Central Station, the steel towers of which will arise on a 6,400-acre tract, comprising nearly ten square miles of land lying east of Port Jefferson, with a long frontage on Long Island Sound. The preliminary engineering studies have been completed, contracts for all the construction materials are being let, and a force of radio experts, after months of preparation, will immediately take the big job in hand.

A definite idea of the ultra-modern character of this radio plant may be gained from the observations of Edward J. Nally, president of the Radio Corporation of America, under whose direction the world wide wireless system has emerged from an idea into a reality. "Everyone at all familiar with wireless," said Mr. Nally, "knows that at Nauen, Germany, and Bordeaux, France, are two of the largest stations in the world. Up to now they have been viewed with admiration; consider, then, the tremendous advance represented in this latest step; the New York Radio Central Station, in the aggregate, will be five times more powerful than either of these!"

He explained that there will be five complete transmitters, each one a duplex unit with a corresponding receiving station located nearby. All five transmitters and the five receivers will operate simultaneously and will transmit and receive messages over thousands of miles continuously during day and night.

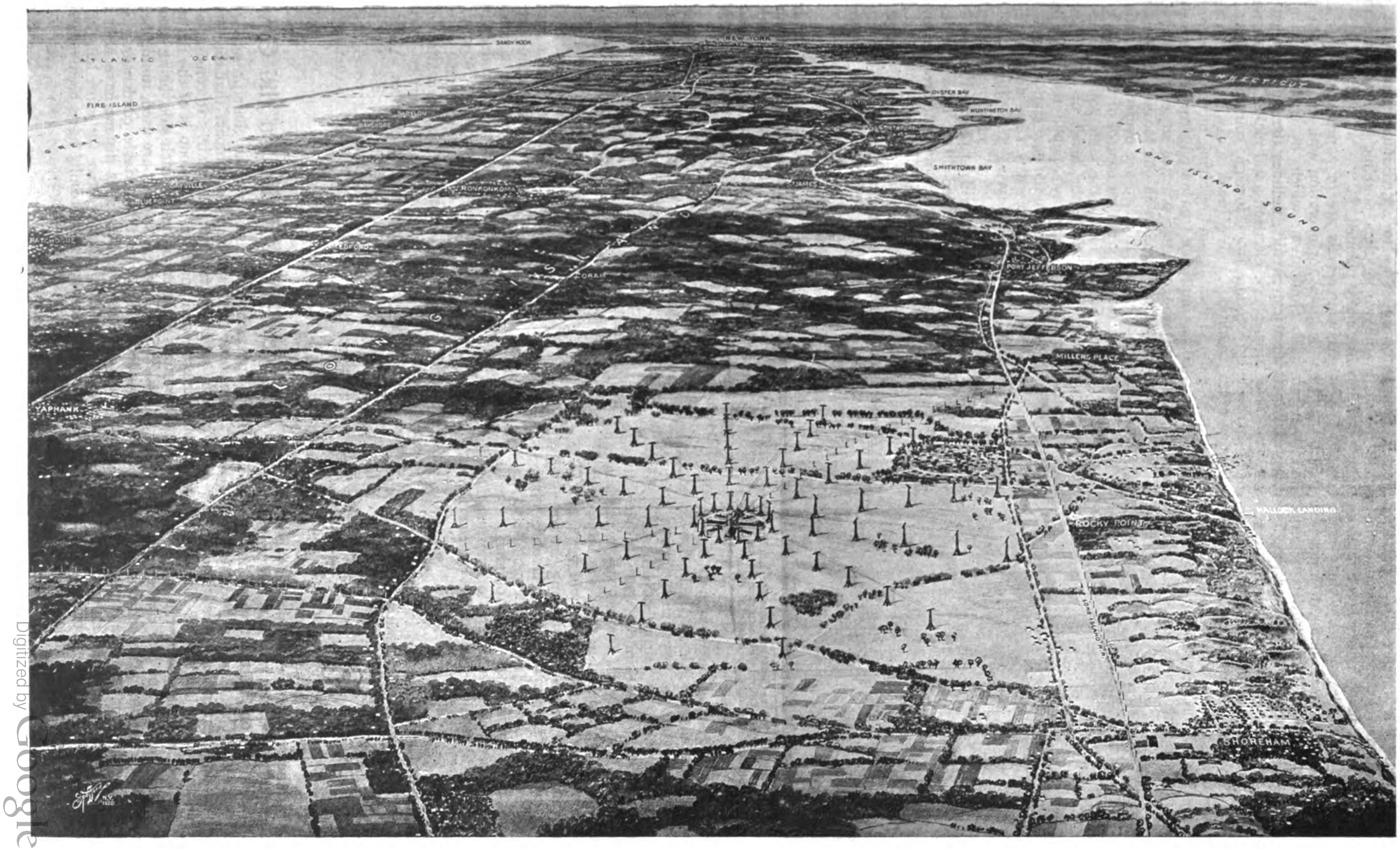
"New York will be the direct focal point of world's intelligence in an entirely new sense under this communication scheme," he continued. "As soon as the station is completed immediate message service will be established with France and Germany to supplement the existing commercial circuits; ultimately, radio from this station will connect up Buenos Aires and other points in South America, and etherwave messages will be flashing to and from Poland, Sweden, Denmark and other European countries. Like the ripples that race in circles over a pond when a stone is dropped in the water, the electro-magnetic waves from this station will soon encompass practically the whole of the civilized globe. It is a plant that dwarfs all existing wireless stations into insignificance; a single unit will have power and range the equivalent of the largest wireless stations in the world today.

"The form of aerial construction, too, is wholly a new departure. From the central power house six spans of aerial wire will radiate out in a star pattern to a distance of more than one mile from the center. The wires of this huge antenna will be supported on self-supporting steel towers, each 400 feet in height, with the wires suspended at the top between 150-foot cross arms. Each of the six antennae will have twelve towers, forming so to speak, the spokes of a giant wheel fashioned out of seventy-two miniature replicas of the famous Eiffel Tower in France. Five of these antennae spokes will be used for regular service while the sixth is reserved for emergency operation.

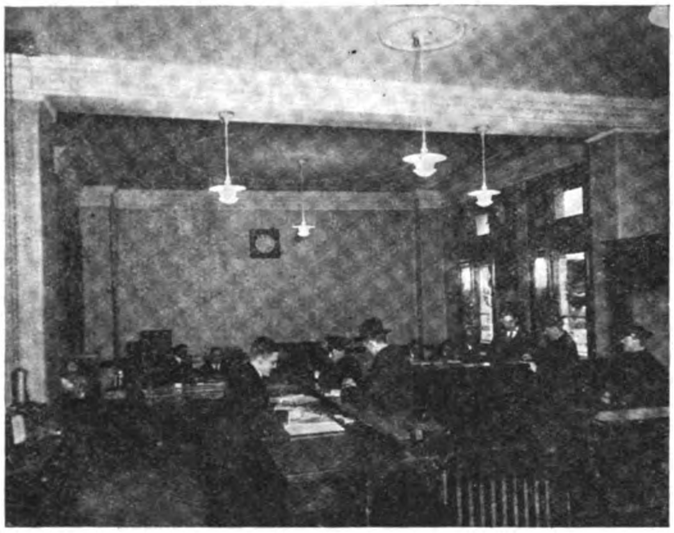
"Far more impressive than physical appearance, however, will be the things the eye cannot encompass," Mr. Nally explained. "Appreciate," he said, "that in the wires forming each spoke of the gigantic wheel there will be generated a power equal to the greatest of present day trans-oceanic wireless stations; then comprehend, if you can, the fact that all five of these powers can if desired, be combined into one, for signaling. A telegraphic signal created out of such tremendous electromagnetic energy could encircle the entire globe!

"But that is not all. The apparatus and system which will be installed for each of the five units will be the same as that at present in our New Brunswick (N. J.) station from which the voice of Secretary of the Navy Daniels was carried to President Wilson when he was at sea aboard the U. S. S. 'George Washington.' In a number of experimental tests the voice has been carried by this radio telephone over distances of 2,500 miles with complete success. This leads us to state very definitely that before long a direct wireless telephone service will be established with foreign countries."

Every exacting requirement of commercial radio message service will be satisfied fully in the apparatus and system of circuits with which the great station will be equipped. The generation of the energy required to span thousands of miles will be effected by Alexanderson alternators, powerful machines constructed by the General Electric Company, which have made it possible to carry the radio signals through space by continuous wave trains, instead of by the interrupted or discontinuous waves, generated by systems using the old-time "spark discharge" apparatus. Taken by itself, the Alexanderson alternator is an achievement rivaling the design of the new world-wide station. This machine is the concrete expression of an ideal which electrical engineers have



View showing the location and tremendous size of the New York Radio Central Station—It will cover 6,400 acres of land east of Port Jefferson, Long Island, with a long frontage on Long Island Sound. This most powerful station will have five complete transmitters, each one a duplex unit with a corresponding receiving station located nearby held for many years, for it represents a perfected generator of high frequency electrical oscillations constructed along the lines of the ordinary power house dynamo. The problems solved by Mr. Alexanderson, chief engineer of the Radio Corporation, were thought insurmountable. Because the transmission of radio signals requires alternating currents of frequencies a thousand times or more in excess of those used in power engineering, it was considered beyond the range of practicability to obtain such currents from a dynamo. In the Alexanderson alternator equipment, the new station will have a source of energy proven as reliable as the power dynamo, yet creating a steady stream of electromagnetic oscillations, which will permit telegraphic signaling at very high speeds. So efficient and reliable has the Alexanderson 200-kilowatt alternator installed at New Brunswick proven itself, that leading radio experts of Europe have made special trips of investigation to the United States to view its performance; now this already famous single machine is to be duplicated and installed in the New York Radio Central Station; but this time there will be two 200-kilowatt machines for each transmitting station—ten in all. The achievement, from a radio engineering standpoint has nothing approaching a parallel: ten alternators, 2000 kilowatts, 3000 horsepower—an astounding force to concentrate in realization of a dream to transmit messages over the world to all points of the compass from a single source!



The office in New York City, where Marconigrams for England, Norway, Hawaii and Japan are handled daily, will also handle the New York Radio Central Station's business by means of distant control

Mr. Nally emphasized another forward step in engineering which will be incorporated in the super-station. "We will utilize what is termed a multiple tuned antenna, which," he explained, "materially reduces the wasteful electrical resistance of the long, low, flat-top aerials formerly used. A great saving in power is thus effected; in fact for the same power input formerly used for a single station, six times the effectiveness at a distance is obtained. In other words, we obtain with this antenna the same effect at a distance with 200 kilowatts input, as would be obtained from the old type of antenna with 1200 kilowatts input. This new type of antenna is the equivalent of six independent radiators, all operating in unison at the same wave length and for the complete station with its five antennae units, the power required will be less than 20 per cent of that formerly necessary. The project, however, contemplates additional possibilities. To illustrate: We may, in many cases, utilize but one-half of a single spoke of the antenna system for communication service to a certain point. On this basis, the Long Island Station will ultimately permit simultaneous transmissions to a maximum number of ten points in the world, thus doubling the communication facilities originally planned.

"The receiving aerials are of a new type, too; they have been designed for operation with the Weagant system of static elimination, which, by a combination of opposed electrical circuits, nullifies the long-dreaded effects of atmospheric electricity and makes possible uninterrupted reception from foreign countries under all weather conditions. We break away from precedent once again, in locating our receiving units only eighteen miles from the multiplex transmitting equipment, instead of following the existing practice of establishing one transmitter and one receiver in one locality and restricting the service of the circuit to one oversea destination."

The arrangements for distant control of the New York Radio Central Station follow the same policy of concentration. In Broad Street, the heart of New York's financial district, the company's public telegraph office is being re-equipped to handle the new station's messages along with the Marconigrams which are now received for England, Norway, Hawaii and Japan. Thus messages for any of the five additional countries reached by the new station will be received in the New York City office and dispatched direct from a series of operators' keys and relays which will operate the powerful transmitting circuits located miles away out on Long Island. Messages from over the ocean will ultimately be received in the same manner, receipt and delivery of the actual messages being effected by the customary messenger boy service direct to the home or office of the user of the trans-oceanic wireless.

It is expected eventually to install apparatus for high speed transmission and reception, which will be under the supervision of a trained staff of operators, along with which there will be the usual staff of expert Morse operators, who will work those circuits over which high speed transmission is not taking place.

Countless details of great technical interest and engineering importance are embraced in the specifications for the station, prepared by combining the personnel of the Radio Corporation and the General Electric Company, an arrangement made possible by the recent merger effected by these interests and the absorption of the Marconi Wireless Telegraph Company of America. Even to the uninitiated in technical matters this gives assurance of perfection of detail in design; equally certain results will follow in the manufacture of the apparatus which has been delegated to the General Electric Company, while the construction of the station will be under direction of the engineering staff of the Radio Corporation. As Mr. Nally expressed it: "The great task is well begun and will progress steadily to a realization of a new conception of the conquest of the barriers Nature has erected between the brotherhood of races. With the speed, accuracy and lower cost of wireless, the new station will give to the world something novel, useful and epoch-making in the field of international communication."

The Board-Walk Chair on the Cover

THE apparatus comprising a radio chair presented on the cover of this issue is so compact that three persons can sit comfortably in the chair. It consists of a loop, detector and amplifier. The loop is of the flat type and measures eighteen inches on each side, being wound with No. 26 S.C.C. wire. No coils are used, tuning being accomplished solely with the variable condenser. Signals from stations over 200 miles distant have been received, and the set is most effective for wave lengths of 300 to 500 meters, but good results have been obtained at wave lengths up to 800 meters.

The Alexanderson System

Its Performance and Operation at the New Brunswick Station

By Elmer E. Bucher

Commercial Dept., Radio Corporation of America

(*Continued from the July Issue*)

THE antennae commonly used at high-power radio stations may be broadly classified into two types, viz., the long horizontal aerials which are suspended on comparatively low towers, and the vertical, fan or umbrella aerials which are generally supported at great heights. The flat-top antenna was adopted for long distance transmission because it was believed to have marked directional properties and would therefore provide maximum radiation in the direction desired and lesser degrees of signal intensity in all other directions.

Experiment has indicated, however, that this directional effect disappears at distances beyond 300 miles or so from the transmitter and thus the benefits of directional radiation are realized only in a limited area. Beyond this the flat-top antenna has been found to have comparatively high resistance. This may be said to be due to the long path through which part of the ground current has to pass to the far end of the antenna, which is a path of relatively high resistance. This resistance cannot be materially decreased by laying wires in the ground, for because of the inductive impedance of such long wires (at radio frequencies) a large percentage of the ground current will still pass through the earth. It is therefore evident that if the length of the ground path in a radiating system could be reduced, a considerable saving of power would be effected.

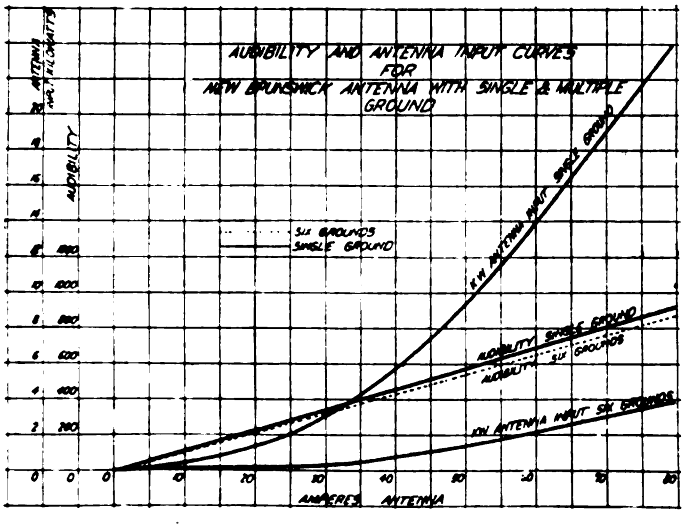


Figure 22—Curves showing comparative signal audibilities obtained from the Alexanderson multiple tuned antenna and the open-ended flat-top antenna

At any given wave length the radiation from an antenna has been found to be proportional to the square of the effective height and the square of the antennae current. The exact relation is $W = \frac{1,600\ h^2 i^2}{\lambda^2}$. This points to the desirability of a high antenna, but since the cost of building such a radiating system increases very rapidly with its height, the factor of economy requires that the money expended on a station be apportioned between the cost of the antenna, power apparatus, and maintenance in order to arrive at the lowest total cost for transmission over a given distance. It is obvious that if, by any means the wasteful resistance of the long, low, flat-top antenna, that is, conductive losses, leakage through insulation, etc., could be reduced, and if its radiation properties still could be maintained, then assuming equal power inputs into the two systems, a station using a long, low and relatively cheap antenna could produce the same signal strength as that from a high and costly antenna.

The multiple tuned antenna devised by Alexanderson brings about a marked decrease in the ground resistance of a flat-top aerial. His antenna can be compared to a station using a number of small antennae connected in parallel, the height of each of which is great compared with their horizontal dimensions. It follows from simple electrical principles that several antennae in parallel will possess a lower joint resistance than a long antenna of the same radiating capacity. The same result may be obtained from the Marconi flat antenna by bringing down leads from the flat-top, at regular intervals, to the ground through appropriate tuning inductances. With this construction it will be seen that the antenna charging current has a much shorter path through the down leads than it had with the former design.

The improved efficiency of the multiple tuned antenna has been amply demonstrated at the New Brunswick station where the resistance of the Marconi flat-top has been reduced from 3.7 ohms to 0.5 ohm with the consequent saving of power.

The curves of figure 22 show the results of a series of experiments conducted between New Brunswick, N. J., and Schenectady, N. Y., with the object of comparing the relative signal audibilities ampere for ampere in the old antenna with a single ground and the Alexanderson antenna with multiple grounds. The results show quite conclusively that with the same current in a flat-top antenna and in a multiple tuned antenna, substantially equal audibilities are obtained at the receiving station. However, the power required by the plain antenna for a given number of amperes is very much in excess of that fed to the multiple tuned antenna for the same total current. Thus as the curve shows, to put a total of 70 amperes in the branchces of the multiple tuned antenna with six grounds, requires but 3 kw., whereas with the flat-top antenna and a single ground, 18½ kw. are required. This is of course a very small proportion of the total output available at New Brunswick. The values shown in the curve should not be taken as indicative of those used in daily operation.

The points of distinction between the two types of antennae may become evident from the following comparative analysis. Thus the flat-top antenna with single ground is shown in figure 23. The equivalent circuit resolved into lumped or concentrated values of inductance and capacitance is shown in figure 24. The schematic circuit of the Alexanderson antenna is that of figure 25 where L_1, L_2, L_3, L_4, L_5, L_6 are current paths between the flat-top and the earth. The inductance of each down lead is made six times the capacitive reactance of the flat-top at the frequency of operation selected. The capacitive reactance of the flat-top is thus neutralized at six places. The circuit is therefore the equivalent of six independent radiators operating in parallel.

The equivalent circuit of figure 25 is that of figure 26, which is an artificial circuit comprising a number of parallel resonance circuits adjusted to the frequency of the alternator N. The branches $L_1\ C_1$, $L_2\ C_2$, $L_3\ C_3$, etc., which are in shunt to one another are fed by the alternator. When each branch is tuned to the frequency of the alternator it will follow the well-known laws for parallel resonance. A large current will flow back and forth between the inductance and the condenser, and the alternator will simply supply power to compensate the resistance losses of the circuits. These large currents are directly due to the high voltages maintained across the inductance and the capacity, when the circuit is tuned for resonance. These voltages may be calculated when the value of inductance or capacitance and the current flowing therein are known.

If a parallel resonance circuit had no resistance, the conditions for parallel resonance would be strictly the same as for series resonance. These conditions are, however, very closely realized in the parallel circuit. In series resonance the e. m. f. on the condenser is equal and opposite to that of the coil and thus there is a large flow of current between the condenser and coil. There is also a large current flowing between the condenser and the coil in parallel resonance, but viewed from the standpoint of the feed or power supply circuit, the feed current is simply the difference of the currents in the condenser and the coil.

The resistance of a parallel-resonance circuit, in radio, is often treated as a negligible quantity. This resistance, however, assumes considerable importance in the multiple antenna as it determines the power taken from the alternator. Thus if the wasteful resistance of each branch in a multiple tuned antenna of six branches is 2.7 ohms, their joint resistance is $2.7/6 = 0.45$ ohm (assuming equality) and it is this resistance plus the radiation resistance of the entire antenna system through which the alternator works.

It is obvious that the alternator can be connected as in figures 27, 28 and 29 with the same effect as shown in figure 26. Thus in figure 27 the alternator terminals are connected in shunt to the parallel resonance circuits. In figure 28 the alternator output is fed to the antenna through the inductive transformer P S. In figure 29 an auto-transformer connection is employed.

In order to obtain resonance between the alternator and the several radiators of the multiple antennae of figures 25 to 29, the joint reactance or impedance of the down leads L_1, L_2, L_3, L_4, L_5, L_6, must be chosen to equal the capacitive reactance of the flat-top at some particular frequency. Hence with multiple tuning at six points the reactance of each down lead, for a given wave length (or frequency), must be six times the capacitive reactance of the whole antenna.

The method of computing the inductance in the down leads for a given wave length is as follows: We may take as a representative example the capacitance of the New Brunswick flat-top antenna, which is a long low aerial of the Marconi type. Its capacitance as measured is 0.066 mfd. Assume that operation is desired at 15,000 meters.

The oscillation frequency,

$$N = \frac{300{,}000{,}000}{15{,}000} = 20{,}000 \text{ cycles}$$

The capacitative reactance of 0.066 mfd. at 20,000 cycles

$$= \frac{1}{2\pi N C}$$

$$= \frac{1}{6.2832 \times 20{,}000 \times 0.000{,}000{,}066}$$

$$= 120.5 \text{ ohms.}$$

The inductance required to neutralize the capacitive reactance is found from the relation

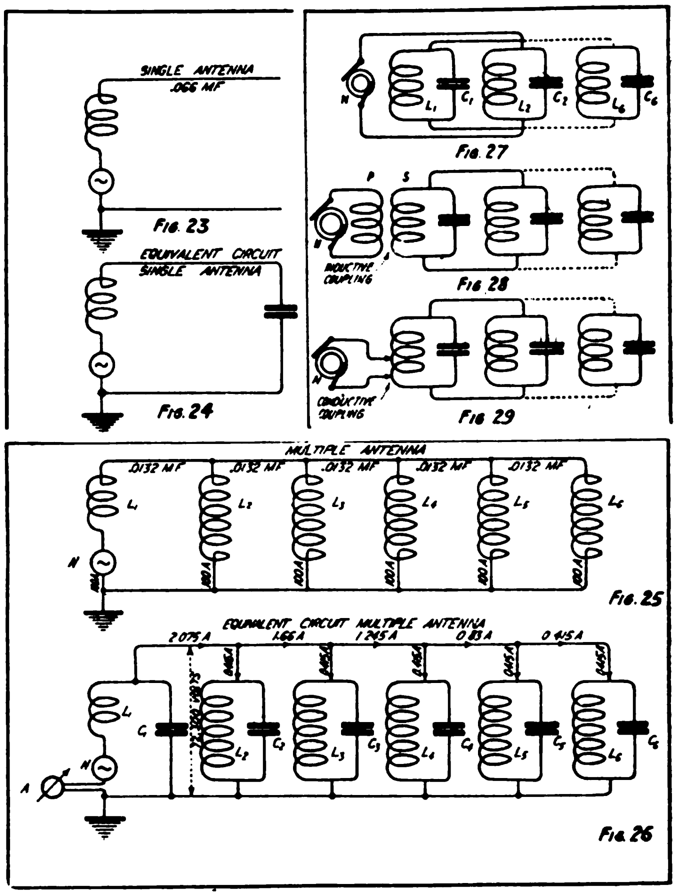
$$L = \frac{X}{2\pi N}$$

$$= \frac{120.5}{6.2832 \times 20{,}000}$$

$$= 0.000{,}958 = 0.958 \text{ millihenry}$$

The total inductance of each down lead should then be 6 x 0.958 = 5.74 millihenry; and the reactance of each down lead, 6 x 120.5 = 723 ohms.

Curves may be prepared to give the values of inductance required to tune the multiple antenna with various number of grounds at different wave lengths. If then the line coils be calibrated for different numbers of turns at different frequencies, it is a relatively simple matter to set these inductances to the correct value for any wave length. A series of curves showing the inductance required to operate the New Brunswick antenna at various wave lengths are given in figure 30. These are cited merely as illustrative examples.



Figures 23 to 29—Fundamental and equivalent circuits of flat-top antenna and Alexanderson multiple tuned antenna

The term "feed ratio," for convenience, has been applied to express the ratio of the total current in the six radiators of the multiple antenna to that flowing in the down lead of the branch to which the alternator is coupled. Assume that equal inductances are inserted in each down lead. With all other conditions equal, the same current will flow in each of the six circuits when supplied with energy at the frequency which produces resonance.

Thus if the ammeter A, when connected in series with the station down lead, figure 26, indicates 100 amperes (at resonance), and the same current is obtained in each branch, the total antenna current is 6 x 100 = 600 amperes.

The feed ratio is then equal to

$$\frac{\text{Total Current}}{\text{Current in the station down lead}}$$

which in this case $= \dfrac{600}{100} = 6{:}1$

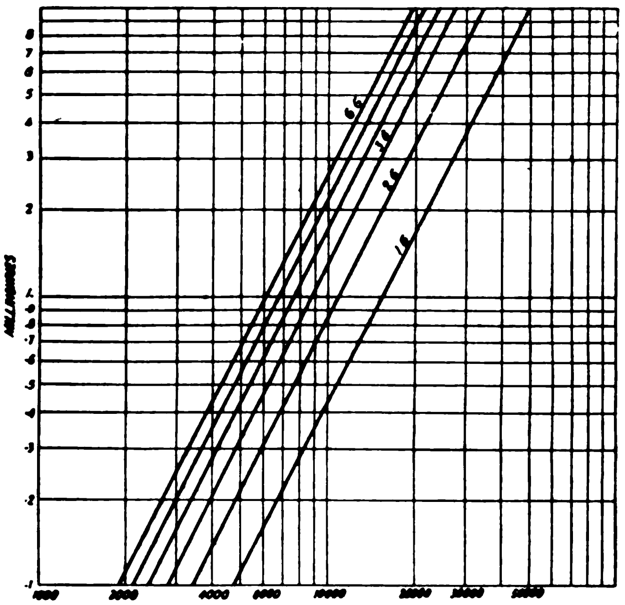


Figure 30—Graphs showing inductance required to tune the multiple tuned antenna at New Brunswick to different wave lengths

It is of interest to note that this feed ratio is only maintained when the inductance in all the down leads is equal. Assume, for example, that the inductive reactance in the branch through which the energy is supplied is decreased and the frequency of the alternator is raised for resonance. Assume also that the feed ratio previous to this change is 6:1, the wave length 15,000 meters, the frequency 20,000 cycles, and the inductive reactance at each down lead 723 ohms. If now the wave length is reduced to 14,500 meters, the frequency increases to 20,700 cycles. This represents an increase of 700 cycles, which is 3½% of the original frequency of 20,000. It may be shown that 1% change in frequency requires a 2% change of inductance for resonance. Hence the inductive reactance in the circuit for 20,700 cycles is 100%—7% or 93% of the value at 20,000 cycles; that is, 93% x 723 = 672 ohms.

Now if the five line coils to earth are left unchanged and since each has an impedance of 723 ohms at 20,000 cycles, or multiple impedance of 723/5 = 144.6 ohms, the impedance at 20,700 cycles obviously is 20,700/20,000 x 144.6 = 149.6 ohms. The new feed ratio is evidently proportional to the two impedances or 672/149.6 = 4.49:1.

The value of this determination lies in the fact that upon changing the wave length by tuning at the station down lead only, the new feed ratio can be computed, thus enabling the operator to ascertain the correct feed current necessary to maintain a given total value of antenna current.

After viewing the physical aspects of the antenna layout in figure 24 it might appear that a disturbing phase angle would exist between the currents in the radiating circuit embracing the alternator, and those in the radiators placed at increasing distances from the power source. It can be shown, however, that for all practical purposes the currents in all the down leads are substantially in phase. Thus in figure 31, the branch L_6 C_6, since it is a tuned circuit, operates at unity power factor and therefore may be treated as a non-inductive resistance of a value equal to

$$\frac{L}{CR}\left(\text{or } \frac{1}{R\,(2\pi N^2)\,C^2}\right)$$

If (at $\lambda = 15{,}000$ m.) $C_6 = 0.011$ mfd., $L_6 = 0.00574$ henry and $R_6 = 2.71$ ohms, then the impedance of any single branch to the e. m. f. impressed thereon is equal to

$$\frac{0.00574}{0.000{,}000{,}011 \times 2.71} = 192{,}500 \text{ ohms approximately.}$$

Since the circuit L_6 C_6 R_6 is in resonance with the e. m. f. impressed at T_1 T_2, the current in it is also in phase with the impressed e. m. f., which may be considered to operate through a non-inductive resistance of approximately 192,500 ohms.

Let the inductance of the flat-top between the fifth and sixth branches be represented by L. The value of L is one-fifth of the total flat-top inductance without loading and in the case of the New Brunswick antenna is approximately 0.00013 henry. We then have in the last branch (L_6 C_6) a current which lags behind the current flowing in L_5 C_5 by the angle θ where

$$\tan\theta = \frac{2\pi N L}{R}$$

$$= \frac{6.2632 \times 20.000 \times 0.00013}{192.500}$$

$$= \frac{1}{11{,}780} \text{ (which is negligibly small)}$$

The phase difference between the sixth and fifth radiator is thus negligible. The phase difference between the currents in branch L_1 C_1 and branch L_6 C_6 is five times as great, but it is still of negligible importance. The currents in the six radiators are therefore in substantial phase, the effect of the inductance between branches is negligible, and the charging currents which are measured currents in the down leads can be considered to be in phase. Since the length of the antenna is but a fraction of the wave length employed and the phase difference is slight compared with the wave length, no appreciable directive effects will be obtained.

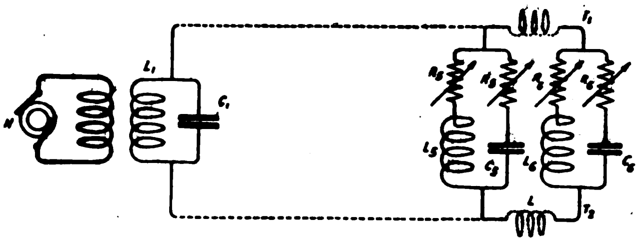


Figure 31—Equivalent circuit of multiple tuned antenna for computation of phase difference

The antenna voltage may be computed when the equivalent capacitance of one section and the current in the station down lead, or the total antenna capacitance and total antenna current are known. This is obtained from the relation, $E = \dfrac{1}{2\pi N C}$ or $E = \dfrac{1}{X}$ where X is the capacitive reactance of the antenna at some frequency.

Using these values, assume that I as measured by an ammeter in the station down lead is 100 amperes. Then since the capacity reactance to be neutralized by the down lead is one-sixth of the whole capacity or 0.011 mfd., then

$$E = \frac{100}{6.2832 \times 20{,}000 \times 0.000{,}000{,}011}$$

$$= 72{,}300 \text{ volts}$$

A current of 100 amperes performs the same functions in each of the remaining branches, so that the whole antenna is maintained at a voltage of 72,300 volts by six separate currents, all in phase, of 100 amperes each. Since the multiple impedance of the six branches has been shown to be 120.5 ohms, the total antenna current is 72,300/120.5 = 600 amperes. This is merely a further proof of the assumption made at the outset.

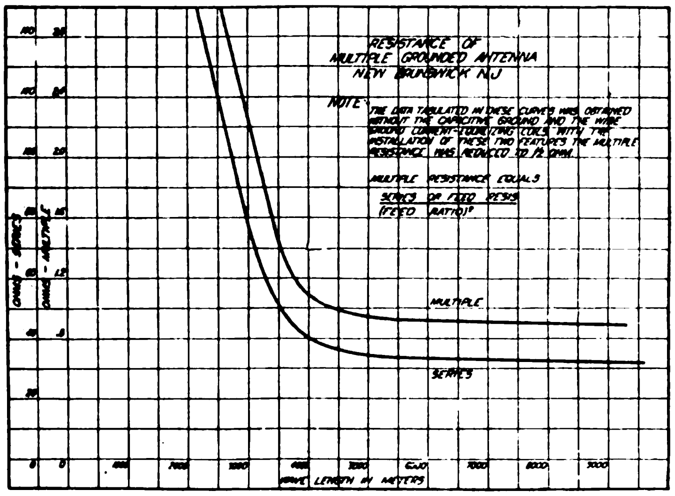


Figure 32—Comparison of multiple and "series" resistance of Alexanderson multiple tuned antenna

As previously cited, the branches of the multiple antenna follow (except in one respect explained later) the laws of parallel resonance circuits with lumped inductance and capacitance, and the current supplied to any branch by the main or power supply circuit is at any instant the algebraic sum of the currents in the capacity and the inductance. If there were no resistance in the branch antenna it would have infinite impedance to the power supply at resonance, and no current would flow in the feed circuit after the initial e. m. f. has been applied. In the actual circuit there must, however, be some resistance and the energy for heating this resistance must be supplied by the alternator, that is, the alternator makes good this loss of energy.

The branch circuit of figure 30 at N = 20,000 cycles, C = 0.011 mfd., L = 0.00574 henry and R = 2.71 ohms, was shown to have an impedance of approximately 192,500 ohms. The antenna charging voltage at 100 amperes is approximately 72,300 volts. The energy current supplied by the power source to one branch is therefore 72,300/192,500 = 0.375 ampere. The power supplied to each branch is 72,300 × 0.375 = 27.1 kilowatts and to the six branches (assuming equality throughout) 6 × 27.1 = 162.6 kilowatts.

The foregoing method of computation while correct for parallel resonance circuits with lumped inductance and capacitance from which no radiation takes place, requires some modification when the phenomena of radiation from the multiple antenna is considered. Thus, in the multiple antenna, the radiation resistance, whatever its value, may be said to be common to all six antennae, whereas the ground and coil resistances belong to the different antennae individually. The combined circuit of the multiple antenna can therefore be represented by a radiation resistance common to all antennae which is in series with a group of six wasteful resistances connected in multiple.

Thus assume now that the radiation resistance of the individual radiators in the multiple antenna (at λ = 15,000 meters) is 0.06 ohm and the ground and coil resistance of each antenna individually, 2.63 ohms. A current of 600 amperes works through 0.06 ohm radiation resistance, while 100 amperes flow through each of the 2.65 ohm resistances. The consumption of power in radiation is $600^2 \times 0.06 = 21.6$ kw., and in each branch $100^2 \times 2.65 = 26.5$ kw., or $6 \times 26.5 = 159$ kw., in the six branches. The total consumption is therefore 180.6 kw.

The point to be brought out is, that if the radiation resistance of 0.06 ohm was added to the wasteful resistance in each radiator, and the energy consumption computed therefrom, the result would be too small. Thus assuming that the total resistance of each antenna was taken as 2.65 + 0.06 or 2.71 ohms, the power in each radiator would be 27.1 kw. and in the six branches, 162 kw., but, as just shown, the correct value, when the radiation resistance is treated properly, is 180.6 kw.

The multiple antenna may be treated in another way. With a total power consumption of 180 kw., the power supplied to each antenna is 30 kw. and the energy current consumed by each oscillating circuit at 72,300 volts is 0.415 ampere. Thus while the total oscillating current is 600 amperes the energy current which flows horizontally from the power source is 2.075 amperes. This distribution is shown by the arrows in figure 26. In other words the energy fed to the system by the first tuning coil in the form of 100 amperes at say 1800 volts is transformed in the first oscillating circuit to 72,300 volts (in the case of the particular problem cited) and distributed as in a transmission line from which 0.415 ampere at 72,300 volts is drawn at five places.

When the inductance in each of the down leads has been adjusted to provide resonance with the alternator and the feed ratio has been determined, the multiple resistance of the Alexanderson antenna can be computed from simple measurements taken within the station house.

The process is as follows: Measure the current in the station down lead at resonance and then measure the open circuit voltage of the alternator (at the transformer secondary). The voltage divided by the current gives the "series" resistance of the antenna from the standpoint of a load on the alternator. This resistance is evidently the combined resistance of the alternator and the "series" resistance of the antenna system. The resistance of the alternator must be obtained from a separate measurement and subtracted from this value to give the "series" or load resistance of the antenna system.

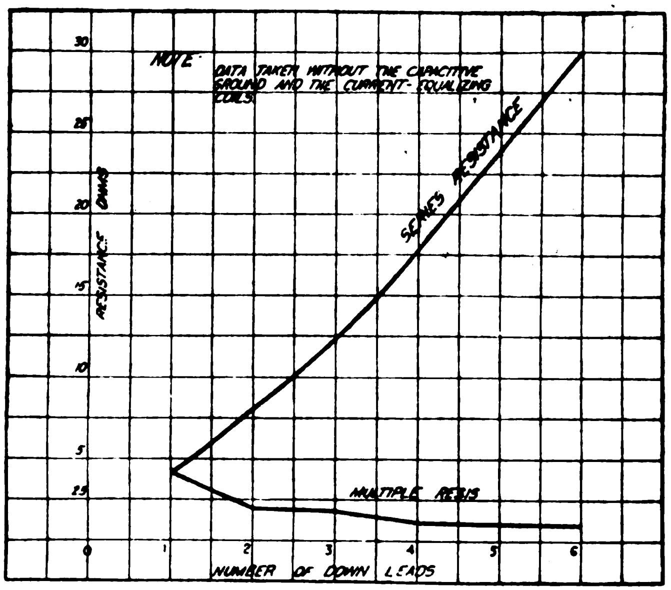


Figure 33—Graphs showing "series" and multiple resistance, New Brunswick antenna with different numbers of down leads

Thus if the open circuit voltage of the alternator transformer is 2000 and the current in the down lead is 100 amperes, the resistance of the alternator plus the "series" antenna resistance is obtained from R = E/I or R = 2000/100 = 20 ohms.

Assume that the alternator resistance (from the standpoint of the transformer secondary) as obtained from previous measurements is 2 ohms; then the series antenna resistance (considered as a load on the alternator) is $20 - 2 = 18$ ohms. The multiple resistance of the antenna is then equal to

$$\frac{\text{Series Resistance}}{\text{Square of the Feed Ratio}}$$

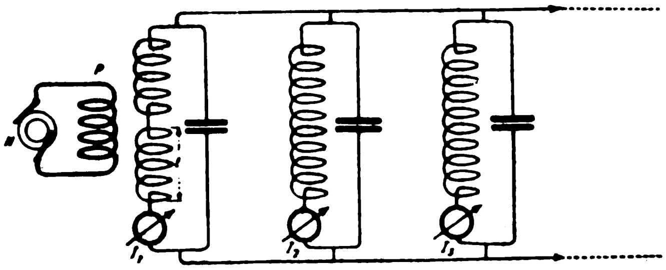


Figure 34—Fundamental circuit of multiple tuned antenna for determining the distinction between "series" and multiple antenna resistance

which in the problem above $= \frac{18}{6^2} = 0.5$ ohm. Proof of this formula is given below.

A set of curves showing the comparative values of these two resistances at the New Brunswick station for wave lengths between 2500 and 9000 meters are shown in figure 32. Thus at $\lambda = 8600$ meters, the series resistance is 32.5 ohms and the multiple resistance 0.9 ohm. It is the latter value that must be used to compare the multiple tuned antenna with the common antenna with single ground. Curves showing the decrease of multiple resistance at New Brunswick with increase of the number of tuning points are given in figure 33. It is to be noted that the data for these curves and also that of figure 32 was taken without the capacitive ground and the current equalizers already described.

In making measurements as above, the transformer must be regarded in all respects as a part of the alternator, that is, the open circuit voltage of the transformer secondary, and the resistance of the alternator from the standpoint of the transformer secondary must be treated as the voltage and the resistance respectively of the alternator.

A proof of the formula Multiple Resistance

$$= \frac{\text{Antenna Series Resistance}}{(\text{Feed Ratio})^2}$$

may be had from the following simple analysis. Reference should be made to the equivalent circuit figure 34, which is assumed to be made up of a number of radiating systems in parallel, all tuned to resonance with the alternator N.

Let E = open circuit voltage of transformer secondary.

Let I = current in the station down lead at resonance.

Let Ra = the effective alternator resistance from the standpoint of the secondary.

Let r = the "series" resistance of the external or antenna circuit considered as a load on the alternator.

Then $E = I\,(Ra + r)$

from which $r = \frac{E}{I} - Ra$

(Ra is obtained from a separate measurement.)

The power consumed in the "series" or load circuit external to the alternator is then,

$$W = I^2 r.$$

Consider now the resistance of the complete antenna from the standpoint of several radiators in parallel:—

Let F = feed ratio.

Then FI = total antenna current in the several radiators.

Also let Ra = multiple resistance of the several radiators in parallel.

Then, the total energy in the several radiators is equal to the product of the multiple antenna resistance and the square of the total antenna current, or,

$$W = (F\,I)^2\,Rm.$$

This energy obviously is the same as that consumed in the circuit external to the alternator, which as shown before, $= I^2\,r$.

$$\text{Hence } (FI)^2\,Rm = I^2 r$$

$$\text{from which } Rm = \frac{r}{F^2}$$

That is, the antenna multiple resistance is equal to the "series" or "alternator load" resistance divided by the square of the feed ratio. Expressed in terms of all the factors involved.

$$Ra = \frac{\frac{E}{I} - Ra}{F^2}$$

It is thus possible to compute the multiple resistance of the Alexanderson antenna from a few measurements made within the station with instruments used in ordinary power work.

Accurate measurement of the current in each down lead is essential, prior to making the above measurements, as equal divisions of current, due to physical factors surrounding the station, cannot always be obtained. Only in this way can the true feed ratio be determined.

The multiple antenna can, under some conditions, be used to advantage with unequal currents through the down leads although, in general, equality of currents gives the lowest resistance. This is apparent from the fact that with unequal division some of the current has a longer path to travel than with equal division, making that particular branch of higher resistance. This also is obvious from the fact that if a given amount of current is to be passed through parallel conductors their joint resistance will be less if the division of current is in inverse proportion to each path.

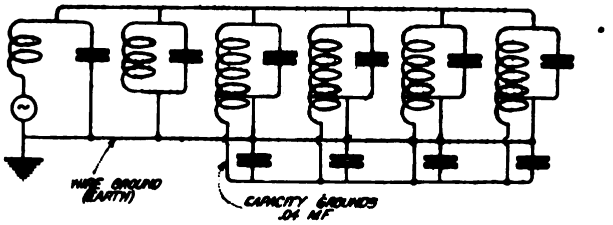


Figure 35—Equivalent circuit multiple tuned antenna, New Brunswick Transoceanic Radio Station

Unequal division of current is an advantage under two conditions. First the "series" or "load" resistance of the antenna can be adapted to the voltage of the alternator, if the alternator voltage cannot be adapted to the antenna resistance. Second, by allowing unequal division of current the wave length of the system can be changed in a much simpler manner than when equal division is maintained. Each change of wave length clearly requires a change in the inductance of all the down leads to maintain equal current division. If the inductance in all down leads is not the same, the current will divide itself in inverse proportion to the inductance of each path.

Further consideration will reveal that for wide changes of wave length it may be advisable to disconnect some of the down leads.

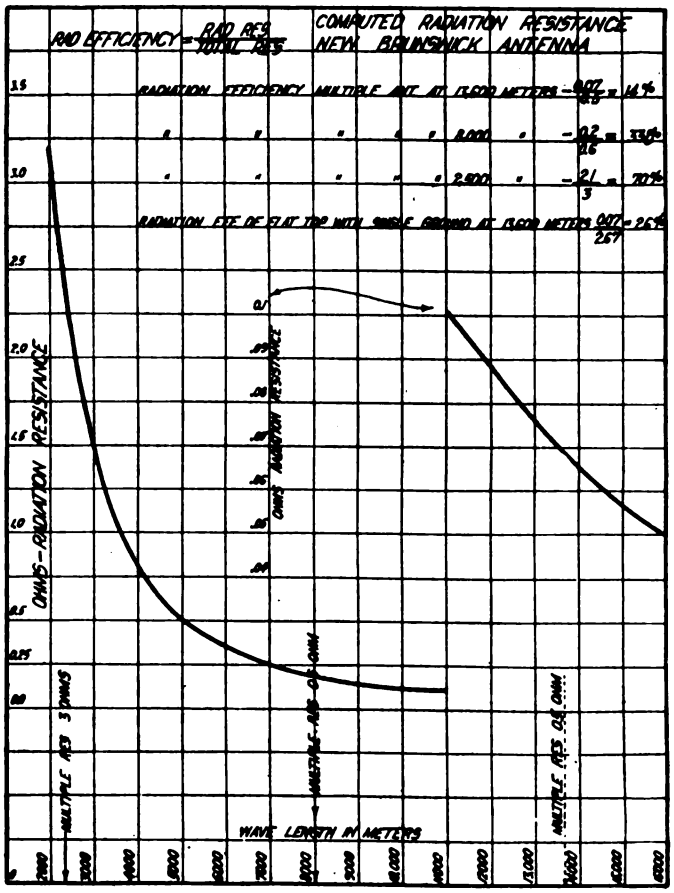


Figure 36—Computed radiation resistance multiple tuned antenna, New Brunswick Transoceanic Radio Station

In order to compute the amount of inductance that is necessary in each down lead at some given wave length, the capacity of the antenna must be measured by the ordinary processes and its capacitive impedance, calculated. This of course, must be computed for each wave length. The capacitive impedance for any other wave length can be obtained from this value, since impedance is directly proportional to wave length. The inductive impedance of each down lead should then be adjusted, previous to tuning of the alternator, to a value six times the capacitive impedance of the antenna, if six tuning points are used. The inductance of the down leads to the tuning coils can be estimated roughly and the value allowed for when placing the tap on the ground coil.

The inductance of the tuning coils should be computed for different numbers of turns at different wave lengths and plotted in a series of graphs as in figure 30. This will simplify the operation of obtaining the correct inductance for any wave length. In case there are no means at hand of calibrating the tuning coils, the required number of turns may be selected by trial. The supposed number of turns required can be estimated roughly and connected in all six down leads, but an allowance must be made in the case of the station down lead for the inductance of the alternator (or for the inductance of the secondary coil of the transformer). The speed of the alternator may then be varied until resonance is found. If the number of turns selected tune at too long a wave length too much inductance has been inserted in the down leads, and if it tunes at too short a wave length not enough inductance has been added.

A general description of the earthing system at the New Brunswick station has been given. In the early experiments it was found that when connection was made from the tap on the down lead inductance to the wire ground, the inner wires carried the greater proportion of current, due to the fact that they offered less impedance than the outer wires. A more equal current distribution was obtained by inserting the equalizing coils between the line inductances and the earth wires as shown in detail figure 15. These coils are in inductive relation and are connected to pairs of the buried wires as there shown. The effect was to increase the impedance of the wires nearest the center and therefore to force practically the same amount of current in the outside wires as in the center wires. This lowered the antenna resistance from 0.9 to 0.7 ohm.

A still better distribution of the earth currents was obtained by installing the counterpoise already shown in figure 16. As is shown schematically in detail A, figure 16a, the section of the coil above the ground connection may, for purposes of illustration, be considered as positive with respect to the ground and the section below the point at which the ground is connected may be considered as negative with respect to the ground. The capacitive ground may therefore be considered as a combination of a forced and a tuned oscillation circuit. It has the effect of drawing the current from the ground more uniformly, than with the wires lying on the ground or buried beneath the surface. The addition of the counterpoise in the case of the New Brunswick station reduced the antenna resistance from 0.7 to 0.5 ohm.

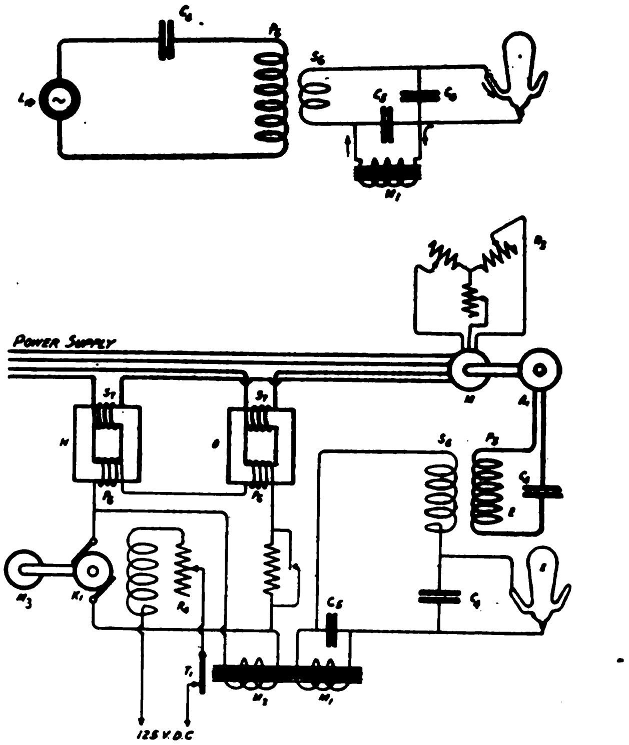


Figure 37—Fundamental circuits of speed regulator of the Alexanderson radio frequency alternator system

By suitable tuning, the total current through the down leads may be distributed between the capacitive ground and the wire ground in any desired ratio. If the wire ground is disconnected and the capacitive ground is tuned to take all the antenna current, the capacitive ground then takes on the characteristics of a tuned circuit. In this case the wire ground may be connected to the zero potential point on the coil (which may be found by experiment), under which condition it forms a path to earth for the lightning discharges with no other appreciable effect upon the system. An efficient ratio of current in the wire and capacitive ground is half of total in each. The capacitive ground may be installed in separate units at each tuning point, or may be connected together as a single unit as shown in figure 16.

Taking into consideration the counterpoise and buried wire ground, the equivalent circuit becomes that of figure 35.

It may be well to point out here that the design and construction of the grounding system for the multiple antenna may undergo considerable modifications in future high-power installations. It is probable that the system can be considerably simplified and yet provide a lower antenna resistance than that obtained at the New Brunswick station.

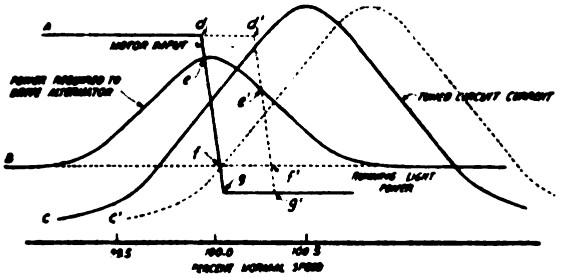


Figure 38—Graphs of Alexanderson speed control system

An antenna with a single ground and effective height equal to that of the New Brunswick aerial, can be assigned at the wave length of 15,000 meters a radiation resistance of 0.06 ohm and a total resistance of 2.71 ohms. This is, in fact, about the values that would be obtained in practice. The radiation efficiency is therefore 0.06/2.71 or 2.21%.

As a multiple tuned antenna the resistance of the New Brunswick aerial is slightly under 0.5 ohm, and the radiation efficiency is 0.06/0.5 or 12%. The radiation efficiency of the multiple antenna at this wave length is therefore 12% against 2.21% in the individual antennae.

The radiation efficiency of the multiple antenna is very much higher at the wave length of 8,000 meters which has been found the most suitable for radio telephony. Thus the radiation resistance of the New Brunswick antenna at 8,000 meters is 0.2 ohm and the multiple resistance 0.6 ohm. The radiation efficiency is 0.2/0.6 or 33%.

It is important to note that the New Brunswick antenna may be operated at the wave length of 2,500 meters, although its natural wave length as a flat-top antenna is 8,000 meters. Operation at such short wave lengths obviously would not be possible with the antenna in its old form. The multiple resistance of the New Brunswick antenna at 2,500 meters is 3 ohms, and the radiation resistance is 2.1 ohms. The radiation efficeincy is therefore 2.1/3 or 70% whereas with a single ground antenna the resistance at the same wave length would be about 5.4 ohms, and the radiation efficiency, 2.1/5.4 or 40%.

A curve showing the computed values of the radiation resistance of the New Brunswick antenna, at various wave lengths, is given in figure 36. The multiple resistance as actually measured at the wave lengths of 2,500, 8,000 and 13,600 meters is pointed out. The radiation efficiency at these three wave lengths should be noted, and also the comparative efficiencies of the common antenna with the single ground and the Alexanderson antenna with multiple grounds, at the wave length of 13,600 meters.

Although the radiation efficiency of all types of antenna decreases with increases of wave length the smaller absorption obtained at the longer wave lengths offsets this decrease. Efficient wave lengths for trans-oceanic communication have been found to lie between 10,000 and 20,000 meters.

As pointed out in the July Wireless Age, in order to secure a constant output at the alternator and to prevent a diminution of the received current at the receiving station, the speed variation of the radio frequency alternator, when signaling, must be maintained within one-tenth of one per cent. It is evident that the governing mechanism to maintain such constant speeds must come into such a critical state, at the motor speed to be maintained, as to cause a high percentage of change in itself for a low percentage change in speed.

The circuits of the Alexanderson speed regulator have been shown in the fundamental station circuit, figure 19. They are shown separately in figure 37. L_{10} is an armature coil which supplies a constant voltage at the frequency of the alternator. C_4 and P_5 are a capacity and an inductance which are tuned to a frequency slightly above that at which the alternator is to be worked. The coil S_6 is coupled closely to P_5, but not so closely as to affect appreciably the tuning of the resonant circuit. E is a rectifier (of the G. E. Tungar or Mercury Arc type) which is shunted by a condenser C_4 of 0.16 mfd. capacity.

M_1 is an auxiliary control coil of the voltage regulator. The latter through the contacts T_1 acts to control the voltage of a generator K_1. C_5 is a condenser of 1 mfd. shunting the coil M_1. Care is taken that the circuit S_6, C_4, C_5, is considerably off resonance with the frequency of the circuit L_{10}, C_4, P_5, in order that the speed held by the regulator may be changed with the greatest simplicity.

N and O are variable impedances connected in the two phases of the power supply lines. They contain the D. C. control coils P_6 and the variable impedance coils S_7. R_3 is a liquid rheostat connected in the circuits of the rotor.

The generator K_1, which is driven by the motor M_3, is provided with field current from a D. C. source of constant voltage which is varied by the rheostat R_4.

In regard to the functions of the impedances N and O, it may be said, in general, that with zero current in the control coils P_6, their impedance becomes a maximum. If on the other hand the current through P_6 is such as to saturate the cores, their impedance becomes a minimum. Any intermediate value of D. C. control current will vary the A. C. impedance of the coils S_7 accordingly.

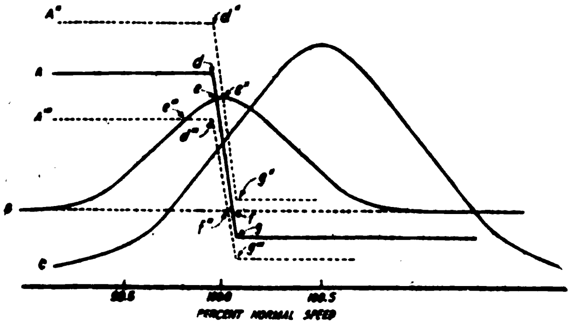


Figure 39—Additional graphs showing certain characteristics of the Alexanderson speed control system

It will now be shown how the motor input may be varied inversely as the current fed into the coil M_1 from the resonance circuit brought from a coil in the armature. Since the circuit L_{10}, C_4, P_5, is resonant to a frequency slightly above that of the alternator, it will develop an increased current as the motor M speeds up. This will send a D. C. component through the coil M_1 which assists that flowing in coil M_2; this causes the voltage regulator proper to maintain a lower voltage at generator K_1. This in turn decreases the current through the coils P_6 and therefore increases the impedance in the power supply circuit, tending to decrease the speed of the motor. When the speed falls slightly the rectified component through the coil M_1 decreases, thus causing the voltage regulator to maintain a higher voltage on the generator K_1 and therefore increase the control current through P_6, and thus again decrease the impedance in the power supply circuit. A given mean current is thus maintained through the control coils P_6, the value of which is determined by the value of the current through M_1. The speed of the driving motor is thus held constant.

A series of graphs showing the phenomena involved in the action of the speed regulator are shown in figure 38 and figure 39.

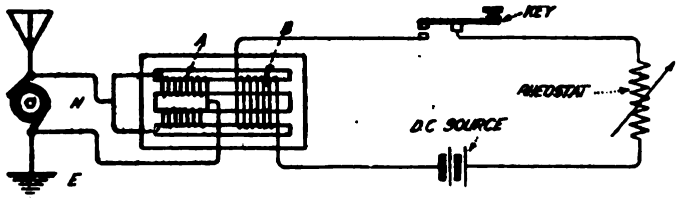


Figure 40—Magnetic amplifier in simplified form

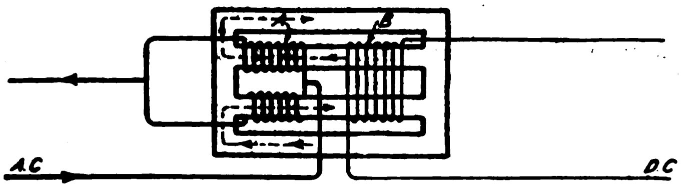


Figure 41—Showing inductive action of amplifier windings upon the control winding

In curve A, figure 38, the "motor input" is plotted against "percent variation of normal speed" with the normal line voltage and frequency and with the resistance R_3 (in the rotor circuit of the motor) properly adjusted to provide the required power. The flat part of the curve to d, indicates the motor input with maximum field on generator K_1, figure 37, which is the result obtained with zero current in the coil M_1 of the voltage regulator. It should be noted that the motor input with the speed less than 99.95% normal is well above that required to drive the alternator with the sending key closed. The motor will therefore increase its speed up to point d, where the speed regulator takes hold. From here the motor input drops off rapidly because of the increasing current in coil M_1 (of the voltage regulator) until its curve intersects curve B which represents the power required to drive the alternator at point e. Here the motor input and the power required to drive the alternator are equal and the speed will remain constant.

When the key is opened, the power required to drive the alternator drops off to that indicated by the dotted line and the surplus of power supplied to the motor speeds up the alternator until the motor input has dropped off to a value equal to that required to run the alternator light. This condition is represented at the intersection f at 100.05% normal speed.

Point g represents the point at which the speed regulator has decreased the motor input the maximum amount possible, with minimum field on generator K_1; and for any small increase in speed above this point, the input will be the same as at g. Since here the power required to drive the alternator is greater than that supplied to the motor, the motor will slow down until equality is obtained as at point f with the key open, or as at point e with the key closed. With the speed at point f when the key is closed, the speed will decrease to point e, and when the key is opened again, it will increase again to that represented by f. This speed variation being less than 0.1%, no inconvenience is suffered.

If, however, the characteristics of the speed regulator are such that it lags in action, the speed may fall below e, before the regulator can effectively increase the power input. This will cause a greater variation of speed than would otherwise obtain. "Hunting" may then take place and result in a speed variation greatly in excess of the allowable variation for constant alternator output. This is prevented by properly designing the whole set

The speed held by the regulator at a given alternator frequency may be changed to some other value by retuning the circuit L_{10}, C_4, P_5 through variation of its capacity or inductance. This will change curve A figure 38, which will then maintain the same relation to the curve C, thus providing a different speed at which the power required to drive the alternator will equal the motor input. These conditions are represented in dotted lines in figure 38, e' and f' representing the speeds held with the key closed and open respectively, and d' the point at which the speed regulator takes hold.

To obtain proper regulation the speed regulator must be adjusted so the point e will be on the left or lower side of curve B, for on that side of the curve an increase in speed will incur an increase in load (as resonance in the alternator antenna circuit is approached) which automatically will tend to keep the speed down. On the other hand if the point e lies on the high side of the curve B an increase in speed will decrease the load which will tend to cause still further increases of speed. This is prevented only by the fact that the speed regulator causes the motor input to fall off faster than the load falls off. Because of the fact that better regulation is secured on the low side of the curve, it is called the stable side, and the high side the unstable side.

If the power supplied to the driving motor is increased, such as by an increase in line voltage or frequency, or by a change in the setting of the motor circuits (such as a decrease in the rotor resistance of an induction motor) the curve for motor input will rise as to A", figure 39. If the power supplied to the motor is decreased the curve of motor input will fall as to A"'.

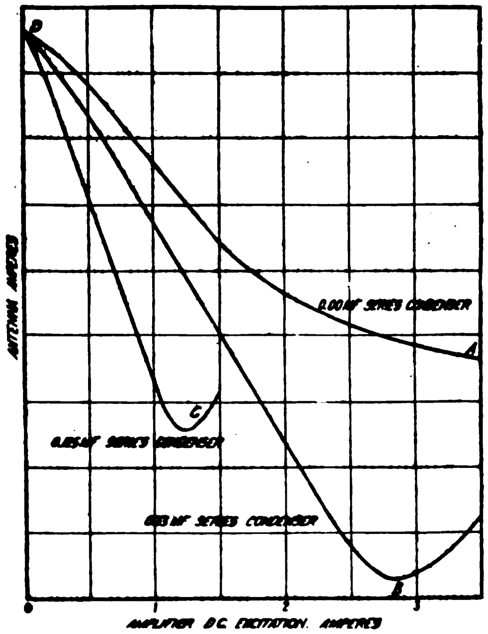


Figure 42—Control characteristics of the magnetic amplifier

The motor adjustment must be maintained so that point g on the motor input curve will be kept well below the power required to run the machine light (as shown by the dotted lines) and also point d must be kept well above the power required to drive the alternator at maximum tune of the antennae. In case point g is not well below the power required to run the machine light a surge in line voltage or frequency might increase it to g'' where it would be greater and thus cause the alternator to run away when the sending key is left open a short interval. Also if point d is not well above the power required to drive the alternator at maximum tune a slump in line voltage or frequency might decrease it to d''' and thus cause the machine to slow down to e''' when the key is closed, with a consequent falling off in signal strength and a swing in the pitch of the received note.

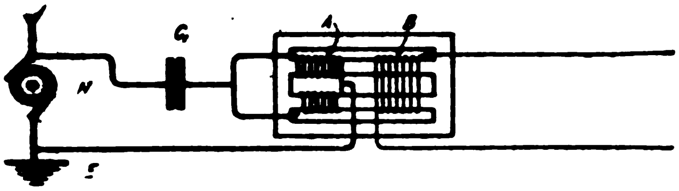


Figure 43—Magnetic amplifier with series condenser

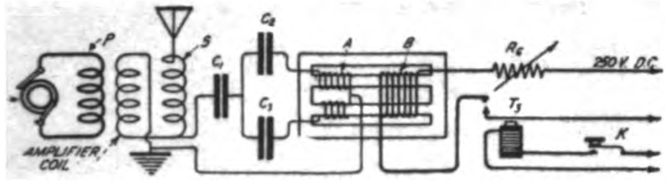


Figure 44—Magnetic amplifier with series and short-circuiting condensers

If adjustments are made so that the conditions outlined above are realized, no difficulties are encountered in maintaining a uniform speed at any desired alternator frequency.

This device already has been described as a variable impedance connected across the terminals of the radio frequency alternator for the purpose of controlling the power input to the antenna circuit. Its characteristics are such that a relatively small current in an excitation winding is enabled to control many hundreds of amperes in the antenna system. The amplifier performs two functions: When the sending key proper is open the alternator is placed on short circuit and the antenna system detuned. The joint effect of these two phenomena is a reduction in antenna current to 9% of its normal value. When the sending key is closed, the alternator assumes substantially its normal voltage, the antenna system returns to a state of resonance and the alternator output flows into the antenna system.

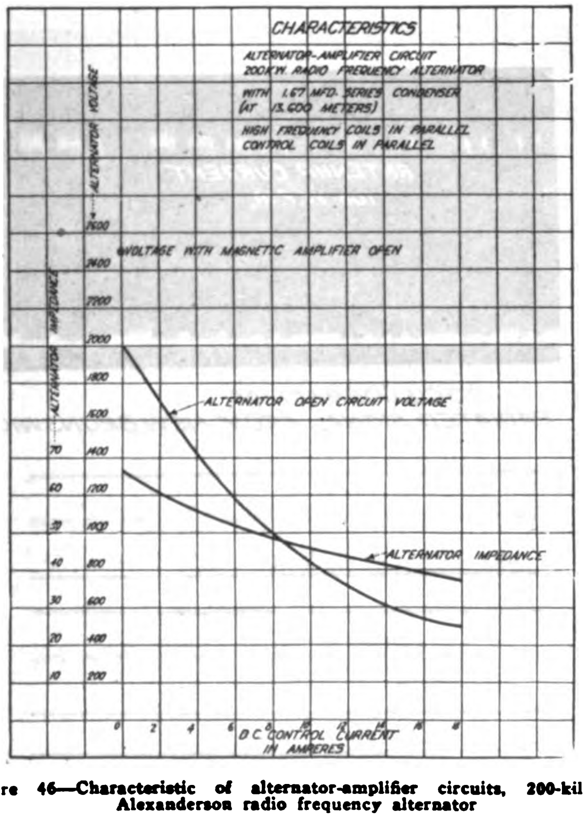


Figure 46—Characteristic of alternator-amplifier circuits, 200-kilowatt Alexanderson radio frequency alternator

The great advantage of the amplifier over other methods of modulation is that it gives a non-arcing control of the large currents required in high-power radio transmission and therefore permits rapid telegraph signaling. In fact the amplifier has been operated experimentally at speeds in excess of 500 words per minute with perfect success.

An idea of the fundamental actions of the amplifier can be gained from the circuit, figure 40 where the two windings designated by A and B are wound on a common iron core. The windings A are connected in parallel and shunted across the radio frequency alternator N. The coil B is an excitation winding which includes both the positive and the negative branches of the flux produced in the windings A, and hence, no voltages are induced in B by the radio frequency currents flowing in A. This is illustrated by the reference arrows in figure 41, which show the direction of flux in the amplifier coil at a particular half-cycle of the impressed current. It is clear that the tendency to induce an e. m. f. in one side of the control coil by one branch of A is counteracted by an opposing e. m. f. in the other branch.

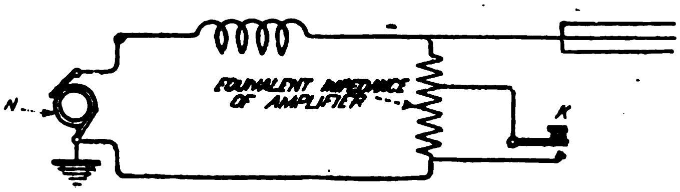


Figure 45—Equivalent circuit of Figure 44

It is apparent that should the flux produced in the core by the coil B be sufficient to saturate it fully, the impedance of windings A would become that of a coil without an iron core. On the other hand, with zero current in the winding B, the core will be magnetized by the windings A, and the impedance of A will thus become a maximum. In general, in order to obtain large flux variations in the windings A, the opposing ampere-turns in B must be approximately equal to those in A. Utilizing the alternator control circuit to figure 40, the problem is to obtain a minimum impedance in the windings A when the circuit to the excitation or control winding is closed and thus short circuit the alternator; and to obtain a maximum impedance when the control circuit is open, so that the alternator may assume within reasonable limitations its normal voltage. In this way the necessary variation of the antenna current for telegraphic signaling is secured.

The characteristics of a magnetic amplifier operated in a given instance as in figure 40, are shown in the curve A figure 42, where antenna amperes are plotted against different currents in the excitation or control coil. The curve A shows incomplete modulation of the antenna current, but it should be mentioned that with this circuit it is possible to secure more complete modulation with stronger currents in the control winding.

A more sensitive control of the alternator output to the antenna system can be secured by the series condenser C_1 of figure 43, for by the use of this condenser a much smaller control current is required to effect a given variation in antenna current. If the capacitance of C_1 is chosen to neutralize the inductance of the windings A for some definite value of excitation current in the control coil B, the impedance of the circuit C_1, A, becomes a minimum. The impedance at any lower excitation is determined by the difference between the inductive

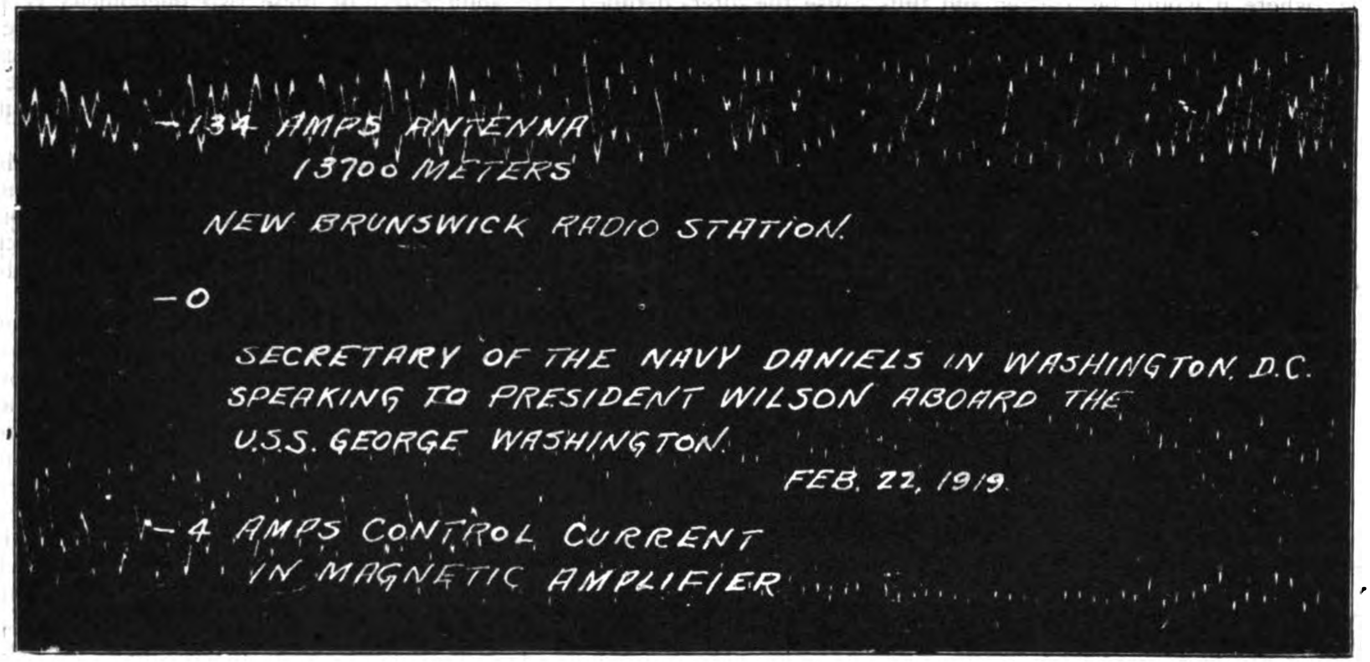


Figure 47—Oscillograms of control and antenna currents using a 200-kilowatt Alexanderson alternator set for oversea radio telephony

reactance of the amplifier coil and the capacitive reactance of the series condenser. However, the smaller this difference the lower will be amplifier excitation which gives minimum impedance and therefore minimum alternator voltage.

The increase in sensitiveness obtained from the series condenser is well shown by the curves B and C of figure 42. The curve A, as already mentioned, shows the antenna currents for different control currents, without the series condenser C_1. The curve B shows the control obtained with a series condenser of 0.33 mfd. and the curve C with 0.125 mfd. The curve B shows almost complete modulation of the antenna current. Although it is a matter of principal importance in radio telephony it is pointed out here that the curve B indicates a linear proportionality between control and antenna currents almost throughout its range. This is an essential requirement for satisfactory speech reproduction in telephony. The excessive control indicated at the right of point B with the larger values of control current is a condition easily avoided in practice.

In the final form of the magnetic amplifier, the condensers C_2 and C_3 are inserted in the amplifier windings A, as shown in figure 44. Their function is as follows: If telegraphic currents were introduced into the control coil B with the condenser C_2 and C_3 absent, a short circuit current would flow between the branches of A without producing any flux variations to the radio frequency current. This, however, is prevented by choosing values of C_2 and C_3 to have a low reactance to the radio frequency currents and a high reactance to the audio frequency currents. These condensers have no appreciable effect upon the tuning of the amplifier circuit.

In the commercial set the constants of C_1 are selected for the particular frequency at which operation is to take place, and it is therefore only necessary to vary the control current in the coil B until the most complete modulation of the antenna current is obtained. In the event that the alternator is worked at some frequency different from that originally contemplated, a value of C_1 can be found for some definite value of control current in B, at which a minimum impedance in the amplifier coils is obtained.

In summary of the foregoing the equivalent circuit of figure 44 will be seen to be that of figure 45 where the telegraphic key K when closed reduces the impedance of the amplifier and therefore the impedance of the amplifier-alternator circuit. This simultaneously detunes the antenna circuit and reduces the alternator voltage.

Characteristic curves showing the variation of alternator voltage, and change of alternator-amplifier impedance with different values of current in the excitation winding (for the standard 200 kw. set), are presented in figure 46. Thus with zero current in the control circuit the alternator open circuit voltage is 2,000, and approxi-

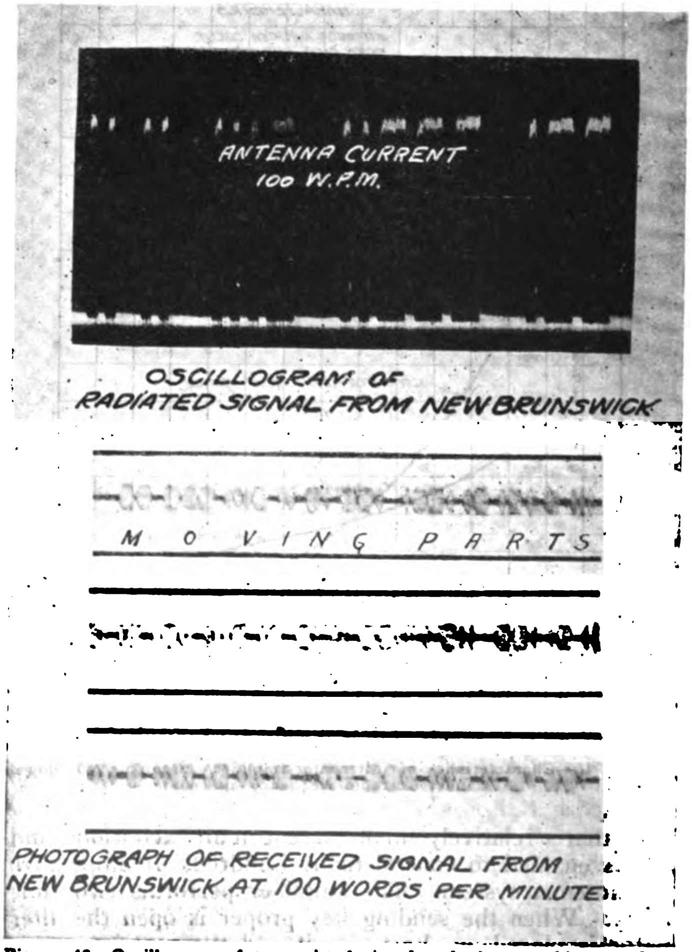


Figure 48—Oscillogram of transmitted signal and photographic record of received signal from New Brunswick Station at 100 words per minute

mately 500 volts with 18 amperes in the control coil. Similarly with zero current in the control coil the alternator impedance is 67 ohms and it drops to 37 ohms with 18 amperes in the control coil. Theoretical considerations of the circuits involved and actual test show that this drop in alternator impedance reduces the alternator voltage and detunes the antenna system to the extent that no more than 9% of the total normal current flows in the antenna system (when the current in the control winding is zero).

In explanation of the control current of 18 amperes (fed by a 250-volt source) in the case of a 200 kw. installation, it may be said that the same variation of alternator output might be obtained with much smaller values of control current. The larger value is purposely used to permit rapid signaling, that is, it permits the magnetic amplifier to function without lag.

Since the magnetic amplifier provides a linear control of the antenna current and functions with small values of control current, it is applicable as a modulation device in radio telephony. When telephonic currents of suitable amplitude are passed through the control coil B, figure 44, similar variations of the antenna current will be obtained, provided the amplifier characteristics are selected to give linear proportionality; otherwise inaccurate speech reproduction will result. It has been amply demonstrated in practice that such characteristics are readily obtained from the amplifier. Thus the curves B and C, figure 42, both show the desired linear proportionality between control currents and antenna currents, but the curve B shows the most complete modulation of the antenna input.

The perfection of control provided by the magnetic amplifier has been well demonstrated in a series of tests made on the 50 kw. Alexanderson alternator. With a telephonic control current varying in amplitude by 0.2 ampere, the antenna current was changed from 5.8 to 42.7 kw., a variation of almost 37 kilowatts.

Figure 47 is an oscillographic record taken on the 200 kw. set at New Brunswick, N. J., with Secretary Daniels, of the U. S. Navy Department, at Washington, D. C., speaking to President Wilson aboard the U. S. S. George Washington at sea. The satisfactory operation provided by the amplifier is here again well demonstrated.

When the Alexanderson System is used in radio telephony, the control circuit of the amplifier is placed in the output circuit of a bank of vacuum valve amplifiers. The input circuits of the amplifier bank are controlled by three preceding steps of vacuum tube amplifiers, which in turn are actuated by the microphone.

In a number of experimental tests made with the telephone set at New Brunswick, the voice was projected to European stations. At distances up to 2,500 miles very satisfactory results were obtained.

Universal, Honeycomb and Lattice Coils

By O. C. Roos

FELLOW I. R. E.

(*Continued from July* WIRELESS AGE)

It is intended in each instalment to "overlap" slightly in regard to the reiteration of basic lattice winding principles involved in order to save the reader the trouble of referring in detail to the previous instalment where these fundamental laws of lattice winding are introduced. As these laws have hitherto been unpublished it is believed that a good educational purpose will be served.—*Editor.*

RESUMÉ OF FIRST INSTALMENT

Unsystematic practices in vogue in naming various universal wound coils noted.

Classification of universal, and lattice coils.

Methods of hand-winding.

Typical winding chart for a step-lattice coil.

General shape factors indicated.

Multi-lattice coils with one or several wires, and use in wavemeters or direction-finder loops.

Laws of lattice pattern-formation.

General approximate inductance formula.

High frequency lattice transformers with ferro-dust dielectric cores.

SYNOPSIS OF SECOND INSTALMENT

Development of lattice layer on a plane, to show true value of "swing-angle," G.

Simple analysis of relations thus exhibited.

First working formulas shown, giving, K the "cross-step" or simply "step" and swing-angle, G and their general connection with tuning efficiency, P of the coil,

where $P = \frac{1}{R} \sqrt{\frac{L}{C}}$

Change of swing-angle with diameter illustrated.

Effect of same on properties of lattice "cells."

Distribution of L, C and R as effected at different layers, by this factor.

Suggestions for conditions of tests to secure better average checks on coil constants.

Effect of wire thickness on properties of coil.

Cross-spiral (or simply "spiral") lattices and their general relations to cross-step lattices.

Peculiarities of lattice coils in relation to derivation of design formulas.

Effect of swing-angle G on lattice-coil tuning efficiency, qualitatively considered.

Method of converting single wire uni-lattice into single wire multi-lattice coils.

General method of designing multi-lattice coils approached.

There is a certain angle, the "swing angle," made by the winding "cross-step" with either circumference of the cylinder faces. It directs the winding zig-zag and experience indicates should not be more than 30°. In figure 15 this is discussed in detail.

To the left in figure 15 we have a coil frame, with a wire "swinging" or "stepping" from O at the "right" of the frame to S at the "left." Let the plane XOY be tangent to the cylindrical frame along the element NO. If we draw OY in this plane at right angles to NO, it will be tangent to the circular face OVB. Let the line OR in the plane XOY represent the wire at a "swing angle" equal to G. Then if the wire OR and the plane is allowed to roll on to the cylinder clockwise, with the line OY always touching OVB, the winding OR will lay on the helical line OS, and will have a "swing angle" of G degrees.

To make the matter still clearer, look at it from another point of view. Suppose that the cylinder NOVB were turned with its ends reversed and then rolled clockwise along the line BO^1Y^1 to the right. If we "inked in" the lines on the plane XOY they would all print themselves on the plane $X^1O^1Y^1$, in their exact relations at the left and we would see why the angle G of the "swing" is the same from point O to point S on the winding. Of course X^1O^1 and Y^1O^1 are perpendicular. NS is the "angular" swing, NO is the width W, and O^1S^1 may be called the "cross-step" instead of "linear swing," for accuracy and brevity.

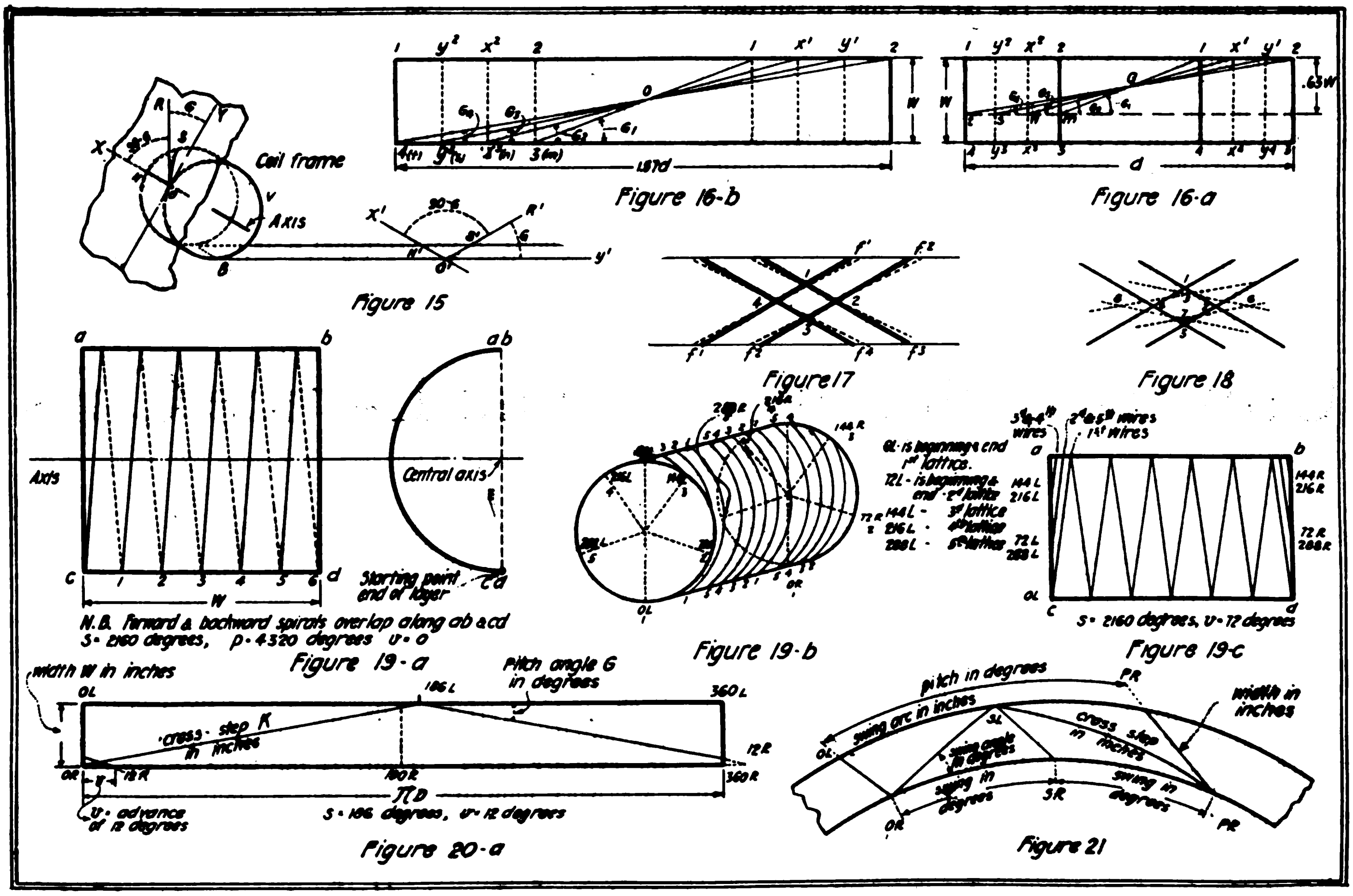
The actual "helical" or "screw" pitch in linear measure is the axial distance along the cylinder traveled during one turn of the winding, like that of any helix, but cannot be greater than W the width of the coil, hence the latter is assumed given and the swing angle calculated from the following two simple relations.

First: $K = \frac{Rds}{360}$

Where K = length of swing—O^1S^1 in figure 15—and therefore equals the "cross-step" or "step" "K."

s = angular swing, in degrees.

d = diameter of winding at a given layer. (N.B. We do not say "diameter of frame.")



Figures 15 to 21—Diagrammatic details of coils showing dimensions, method of winding, angle of pitch and general design principles

Second: $G = \sin^{-1}\frac{W}{K}$ which means that "G in the angle whose sine is $\frac{W}{K}$" and any book of trigonometric tables gives us G as soon as we know W and K. G must be less than 30 degrees. You ask—"why?"

First—It saves wire.

Second—It raises the selective power or tuning efficiency P of the coil, thus cutting down the damping; since

$$P = \frac{1}{R}\sqrt{\frac{L}{C}}$$

From purely manufacturing considerations it is not common practice to build a "step-lattice" coil with the "swing" much greater than 180 degrees.

The sine of 60° = $\frac{1}{2}$, hence $\frac{W}{K}$ must be generally less than $\frac{1}{2}$ or W is less than $\frac{K}{2}$. In the best lattice coils its average value is less than $\frac{K}{6}$. This is shown in figure 16a, where cross-steps K, of constant angle (S) but varying length, are laid out.

Figure 16a is a plane section of a lattice coil. The diameters of four "layers" are indicated by pairs of lines, at left and right. The exact properties of lattice "layers" will be given later. The four lines at the left are 2-3, X_2-X_3, Y_2-Y_3 and 1-4. The winding cross-section at right and left is 1234. If we take .63—the ratio of the diameter of any layer to its semi-circumference—of the width W, and lay out the swing-angles G_1, G_2, G_3 and G_4 by joining m, n, s and t at the left to 1, X_1, Y_1 and 2 at the right, we will find these angles are accurate. Figure 16b proves this; as it is nothing more than figure 16a with the various layers rolled out or "developed" on a plane. The lettering is kept similar to that of figure 16a. The "similar" angles G_1, G_2, etc., in both sketches are exactly equal.

These two figures show that the cell walls of lattice coils slowly change direction as the coil grows in diameter, somewhat like the pitch of a propeller blade. This means that there is a slight mechanical loss of rigidity in lattice "cells" whose linear dimensions are large and flattened as in figure 17a, especially when used with a small diameter of wire.

The wire f_1f_1 is called the "cross-step," and the swing angle G which it makes with the face of the coil, changes as shown in figures 16a and 16b, so that the cell-walls do not receive the support of the "steps" except at a fraction of their length. The dotted lines show the next outer set of "steps." This is shown, greatly exaggerated, in figure 18, where 1, 2, 3, 4 is a cell in one layer and 5, 6, 7, 8 is a cell on the next outer layer. Here is the real "secret" of the lattice coil. The greater the difference between the swing angles of successive layers, the smaller the distributed capacity of the coil, and the more economical it is of wire; since when G is small the time-constant is good. This change is slower near the outer layers, where, however, the effective radial capacity per unit length of coil is also smaller, for electrical reasons.

Since G becomes smaller as the coil diameter increases the inner layers are relatively inefficient in producing a good time-constant. Therefore it is not a fair test to use the whole coil to get the selectivity or tuning power P, which is measured by $\frac{1}{Ro}\sqrt{\frac{Lo}{Co}}$ where Ro, Co and Lo are the radio frequency resistance, capacity and inductances respectively. The whole coil shows up too well!

If the winding were stopped at half the total "layers" to be wound, or else a "tap" taken there, a test for Lo, Co and Ro to represent the uncompleted coil would give a more just average result. The former method is preferable on account of capacity dead-end effects present in the latter method.

It is important to remember that, the thicker the wire, the greater the change of swing-angle with a given change in number of circuits of winding and the less the distributed capacity always provided the spacing between "cell-walls" centers is kept equal to a constant multiple, say 3, of the diameter of wire. Otherwise, these wires of increased diameter in themselves have greater capacity and will neutralize a large part of the above advantage.

SPIRAL LATTICES

It has been stated that for mechanical reasons "swings" or "steps" of more than 186° as given in figure 8 are usually avoided, except when the coil has a ratio of $\frac{d}{W}$ like figure 13 or else is small in diameter.

In these circumstances we may save wire and utilize the rapid change swing-angle G for small diameters—figures 17 and 18—by making the swing angle so small that many turns will be completed before the winding makes one swing. In this case we have a "cross-spiral" —instead of a "cross-step"—when the winding returns with 720° pitch, i.e. two turns or more to the starting point, or just beyond it, making a uni-lattice pattern if the pitch is exactly two turns, i.e. the winding starts a second layer at the original starting point. See figure 19a.

Now if the advance is an exact submultiple of 360° we have, a bi-lattice spiral for an advance of 180°, a tri-lattice spiral for 120° advance and an N-fold lattice spiral if the advance is $\frac{360}{N}$.

A penta-lattice spiral is shown in figure 19b with advance v equal to 72°. We could wind this as a five-wire uni-lattice spiral by starting separate wires at 0°, 72°, 144°, 216° and 288°. By choosing the turns in each lattice we can design an excellent unit for replacing five separate wavemeter coils.

In figure 19b we have the conditions in figure 19a modified to show five separate windings, giving as many lattices, each lattice formed from a cross-spiral. Colloquially we abbreviate "cross-step" and "cross-spiral" into "step" and "spiral" respectively. This spiral lattice or rather "five-spiral lattice" is shown in the forward swing of its first "layer," but for simplicity it is drawn in isometric projection and as though its wires each has only two instead of six complete turns or 2160° to a swing. The left face, nearest the reader, is lettered OL-72L etc., to show the starting points of the first to the fifth wires, as indicated on the top and bottom cylindrical elements 180L-180R,-OL,OR, by the series of numbers 321,54321,54, and 1543215432 respectively.

In figure 19c we get a side view of figure 19b showing, however, the twelve turns made by the first wire on the pitch of 4320°, the forward and backward spirals crossing at the starting element and 180° away. A five-wire spiral-lattice with 10 terminals is the result, although only the beginning and ending of the second, third, fourth and fifth spirals are here indicated.

We have to note, in figure 19a, that $\frac{d}{W} = 1.00$ and the angle G is too small here, to exhibit much change as the new layers are added. The layout of figure 19a is satisfactory, provided the "axial" or "helical" pitch 1-2, 2-3 etc., is at least thrice the diameter of the wire used.

The winding starts at OL—calling OL, OR the zero or starting element—and ends on OR. It immediately returns on the back swing of six turns (not shown) with a total "angular pitch" of 4320°, or twelve turns, to its starting point OL, and therefore, has no spiral "advance," or "step-advance," as shown in figure 1 or in winding-chart figure 8. The layers simply repeat from OL; as no "advance" of any kind is necessary for such a coil, which is therefore of the uni-lattice spiral type.

There is nothing to prevent efficient multiple-wound spiral lattices being used for couplers or wavemeters, etc. There is a positive advantage in it, up to four separate lattices, as the change in G for separate layers of the same lattice is greater, making the cell shape more efficient. These corresponding "layers" for any particular lattice would really be four layers apart radially, and would have their distributed capacity correspondingly reduced, without reducing the inductance too much.

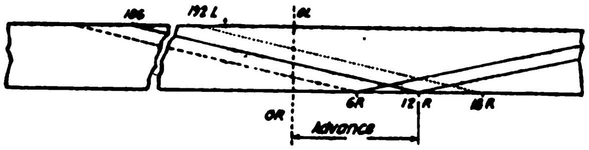


Figure 20b—A uni-lattice coil with swing 186° and advance 12°

It is perfectly practicable to have these "intermediate" wire layers—in this case, 3 layers—replaced by an insulating lattice of moisture-proof hard cord. Such insulating lattices have been used in the past for different purposes. In regard to the mechanics of the thing, it is a fact that in one case, a coil of about four feet diameter was successfully wound out of small diameter rope. Furthermore, the use of large multi-lattice coils of bare and insulated wire for direction-finder loops is today being looked into, as a promising variation both mechanically and electrically.

WINDING PECULIARITIES OF LATTICES, IN RELATION TO DERIVATION OF FORMULAS

There are several unobtrusive points about lattice coils which must be constantly kept in mind.

First: There is no "bedding" of wires at one level in the hollow or trough formed by the two adjacent wires underneath on the lower level. This is shown in the first diagram of this article.

Second: The question "what is a lattice winding level?" is answerable only by accepting a convention. The position of the wires in a "level" is only the same at certain repeated elements of the cylinder constituting the winding. The positions of wires in each level in a "layer" alternate from side to side and the levels themselves have their wires transposed radially in a peculiar way as one mentally passes a plane through the axis and rotates it while examining the winding.

Third: There are small or large projecting bands to be allowed for in calculations of length. These do not occur noticeably in form-wound coils, but lattice coils are not only form-wound, but when constructed of coarse wire with large diameter and few turns, they may be with advantage wound by hand and may purposely have as much as 2.5 per cent of wire added to aid in "tapping" the coil at the wire "bends"—say at a two-inch length of arc projecting from the face of the coil.

Fourth: The length of the wire in a lattice coil is based on the turns per "double level" or "layer," which is the design-unit. It is not convenient to use the "turns per level." This will be shown as being due to the alternate changing of upper to lower levels and vice versa which is illustrated graphically further on in this article.

Turning back to figure 20a we have the elements of the above peculiarities simplified. The perfectly practical winding-plan of figure 8 is given in sketch form. The symbols of figure 1 are applied, with a swing (s) of 186 degrees and an advance (v) of 12 degrees. The development shown in principle in figure 15 is used in figure 20a and the length, say, OL-360L represents the length of the circumference. The swing angle (G) depends, of course, with given cross-step K, on the width of the coil in a "step lattice" winding. In a spiral lattice winding it also depends on the axial width, or rather in this case, the axial length of the coil frame, provided the "cross-spiral" is constant in length. The term "cross-step" or simply "step" for ordinary use, is so much more convenient than the descriptive term "linear swing" (ls) that no excuse is needed for dropping the latter, except as a purely descriptive term. The length of a series of steps is that of a helix of the same angular development. This is obvious if we imagine all the odd or even steps, turned symmetrically to themselves and fitted to the other set, arranged as parts of a broken helix on the coil cylinder considered as extended. The result is a perfect helix, which we treat under the popular generic name of "spiral."

Since the advance v, travels forward by its own length during a certain number of applications of the pitch to the circumference, it must itself be contained in the pitch an exact number of times. Therefore, when the pitch is traveled over once by the advance we have a pattern or a complete lattice "layer." By "slipping" back the starting point when the "pitch" has gone beyond 360° as shown in figure 20b, we form a bi-lattice.

A uni-lattice coil with swing 186° (therefore pitch 372°) and advance 12 degrees, is shown in figure 20b in the full lines. If the swing 186L-12R is "slipped" back to 6R, losing 6 degrees or half the advance, it will come around again, arriving at, say, the swing, 192L-18R, if continued, giving the beginning of a bi-lattice pattern. To continue this bi-lattice, however, this again is slipped back 6 degrees to 12R and the next "circuit," which is defined as a revolution of the winding around the coil frame, starts at 12R, as it would have done originally, with a uni-lattice winding. Here we have the single wire bi-lattice winding. If we started a separate duplicate uni-lattice winding at 6R, and kept it separate, we would have a double or two-wire bi-lattice coil.

In figure 21 we have a value of s of about 30°. We are purposely showing the coil as wide enough to give a swing angle of 35°—an excessive amount. About 10° is good practice for coils about five inches external diameter. This figure also shows the winding surface more in detail than does figure 1.

SYNOPSIS OF THIRD INSTALMENT—SEPTEMBER

1 Laws governing width of coils in terms of "pitch" and "advance," Charts for layout of two types, "odd" and "even" lattices. 2—General relations involving "levels" and "layers" in lattice coils. 3—General properties of lattices in regards to shifting and transposition of wires. 4—Studies in "radial" and "axial" transposition with resultant "banking" of wires and "levels." 5—Detailed graphical analysis of above. 6—Handwinding and tapping of lattices with allowances for same. 7—Changes of swing-angle as related to diameter of wire. 8—Classification of results in preparation for examination of design-factors and formulas. 9—Tabulation of symbols, design-factors and formulas. 10—Selection of 12 coil-problems for mechanical design and comparison of windings. 11—Discussion of same. 12—Solutions of problems. 13—Lines of design development indicated for cross-step lattice coils. 14—Comparison of "cross-step" and "cross-spiral" design factors in lattice coils. 15—Conclusion of analysis and illustration of flexibility of lattice coil nomenclature suggested in this article. 16—Concluding remarks on etymology of nomenclature vs. practical utility in description and specification.

An Impedance Curio

WE ARE all prepared to find an increase of impedance when a condenser shunts a coil. This has been solved for the rejector circuit consisting of a pure capacity and a resistive inductance, about 1892. There are still, however, some very interesting properties of such circuits which have not been published, especially for the case where the capacity has leakage. In all these cases, however, we are prepared to see a sudden change in the reactance of the rejector circuit from condenser to inductor characteristics.

There is another, and a simpler but far stranger experiment on reactive shunts which is shown in figure 1. It seems to contradict the laws of Kirchoff until mathematically investigated. It has been correctly solved by A. Russell and discussed by Howe, Campbell and Still. The writer's work has been done independently of these investigators. In figure 1, x is a pure reactance, S is a pure variable resistance in shunt to x, r is a pure resistance in series with x.

If we apply an alternating sinusoidal potential of amount V to x at C and B and read the current in G and then shunt x by S and repeat the experiment the second reading will of course be greater.

You will probably say this must of course occur in all circumstances! Don't be too sure! Let us restore the series resistance by reconnecting the potential source through Y to A again and then repeat the experiment varying the resistance S from O to infinity.

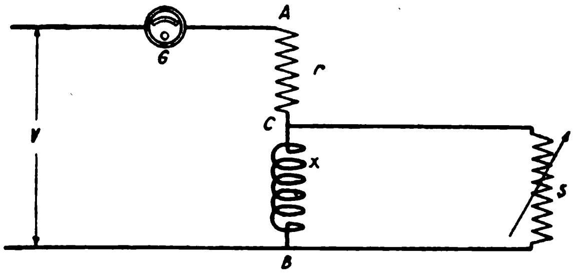


Figure 1—Circuit of the reactive shunt under discussion

Before we do this let us take some actual values. Let x = 10 reactive ohms; let r = 5 resistive ohms. Then the impedance with S open, figures out as 11.18 ohms. For convenience we will assume V equals 111.8 volts, giving a current in G of 10 amperes.

Now reduce S to zero and "short" x with it. The current in G is 22.36 amperes. Increase S and the current in G decreases as would be expected. If we observe carefully we will note that this decrease is unusually rapid. The majority of even experienced engineers would say that we could never reach as small a current as 10 amperes in G unless S became infinite. This is incorrect, however paradoxical the statement may seem!

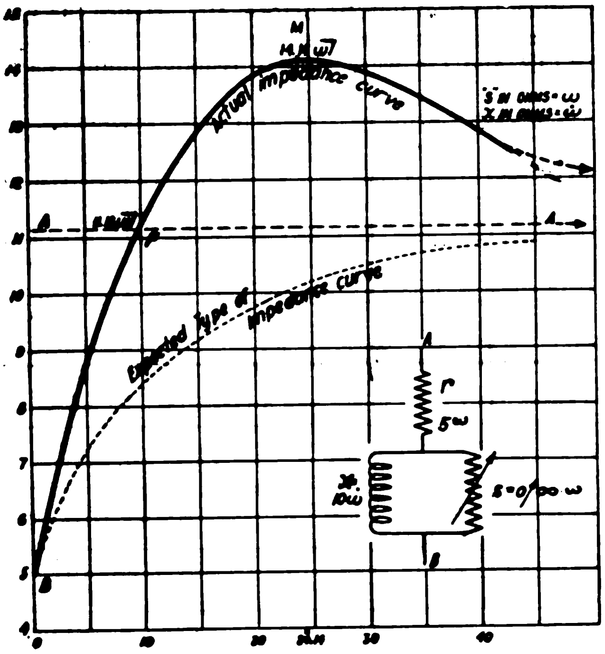


Figure 2—Graph showing actual and expected impedance curves

The obvious proof is, first, that of experiment. Let us increase S to 10 ohms—i.e. to $\frac{x^2}{2r}$ ohms—G now shows 10 amperes! In other words, S makes no difference by its presence, except to change the current phase!

Stranger things follow when S is still further increased; for G shows still less current! S has actually raised the impedance to a value such that the effective value of r has been doubled while the reactance, however, has not been changed, i.e., Z=2r+jx at its maximum. This value for S giving a maximum value of $Z^2=4r^2+x^2$

$$\text{is } S = \frac{x^2}{2r} + \frac{x}{2r}\,(x^2 + 4r^2)^{\frac{1}{2}}$$

$$\therefore S = 24.14 \text{ ohms when } Z \text{ or } Z^2 \text{ is a maximum}$$

$$\text{and } Z^2=100+100$$

$$\therefore Z = 14.14 \text{ ohms}$$

The current in G is now 7.86 amperes.

After this the circuit behaves normally, i.e. when S is gradually increased from 24.14 ohms to ∞ the current in G gradually increases to 10 amperes; since Z equals $r + jx$ when S equals $\frac{x^2}{2r}$ or infinity.

It is possible to solve the problem graphically, but it is advisable, at this point, to plot the graph of the impedance between A and B in figure 1 with S as independent variable.

The graph is shown as the curve BFMR. The interesting points are, first—the impedance at F, or the "final" value of 11.18 ohms which the circuit has when S is opened and second, at M, when S equals 24.14 ohms and shows the maximum impedance always greater than the final value, in this case by 2.96 ohms. The curve is, of course, asymptotic to the line AFA.

The clearest method of showing the relation of the elements which go into the formation of the impedance curve shown in figure 2 is to consider this impedance curve resolved into its two components, R and X, which are the equivalent resistance and reactance respectively.

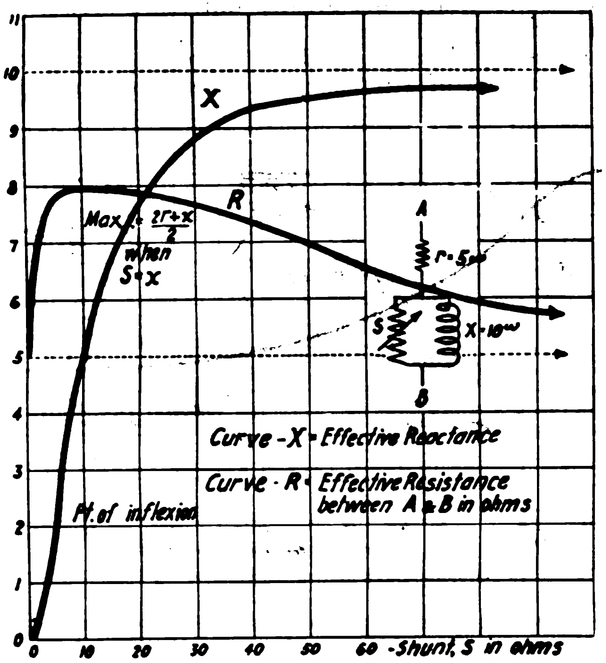


Figure 3a—Graph showing effective reactance and resistance curves

Their values are:

$$R = \frac{r\,S^2 + x^2\,(r + S)}{S^2 + x^2} \text{ and}$$

$$X = \frac{S^2 x}{S^2 + x^2}$$

They are plotted as curves R and X in figure 3a in terms of varying shunt resistance, S.

R has a maximum value when S = x.

In this case $R = \frac{2r + x}{2}$

Now the relation $\frac{R}{\sqrt{R^2 + x^2}}$ gives the P. F. (power-factor) between the points A and B of figure 2 and similar figures. The special points F and M noted in figure 2 have been also noted in the P. F. curve shown in figure 3b, plotted in terms of the shunt resistance, S.

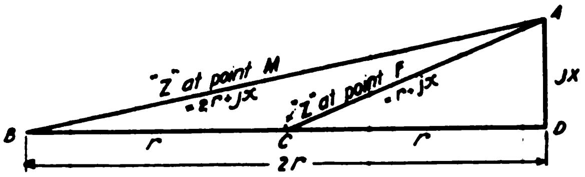


Figure 4—Values of impedance at points F and M in Figure 2

It is easily shown that the P. F. is always 100 per cent. at S = 0 and that there is a point of inflexion at about 8.43 ohms for S.

It is worthy of note that the series resistance r is the important element in producing this maximum. The larger r, the greater the difference between the points F and M as can be seen by an examination of figure 4, where OC gives the impedance shown at point F on the graph in figure 2 and AC gives the maximum impedance shown at point M.

On the other hand, the increasing value of the maximum takes place at decreasing values of S. This makes a sharper and higher maximum.

By examination of figure 4 we find that in figure 2 the maximum impedance ordinate OM is related to the "final" impedance ordinate OF by the equation

$$(OM)^2 = (OF)^2 + 3r^2$$

This shows clearly the greater difference between OM and OF as r gets larger.

Of course, when r is small, we approach the problem of the impedance of a resistance and reactance in multiple, which exhibits nothing abnormal. Its graphical solution is important in order to solve the circuit of figure 1 graphically and will now be taken up. Before going into details, however, the ground will be prepared for the a.c. graphics by first solving for d.c. multiple resistances, graphically.

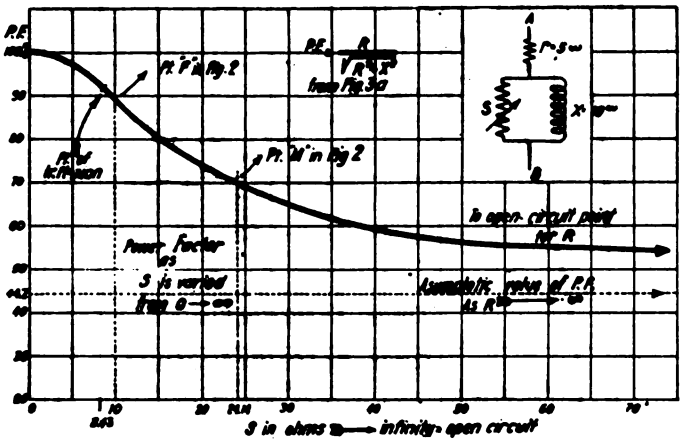


Figure 3b—Graphic curve plotted in terms of the shunt resistance

The graphics of two parallel resistances r and R, with direct current is simply the geometrical interpretation of the expression for their combined resistance $\frac{rR}{r+R}$

Figure 5 gives the well-known solution for this. Take any desired horizontal distance on the axis of abscissas and erect two ordinates at its ends. On these are laid off the values of r and R respectively. Join the points, say, 4 and 8 ohms to the opposite bases of ordinates, by the lines RO and rO. Their intersection marks a point P whose distance from the axis of abscissas gives the value

$$\frac{rR}{r+R}$$

or the multiple resistance of the two branches. It clearly and instantly demonstrates why such a multiple resistance is always less than the smaller resistance. This value, given by the line FP in figure 5 can itself in turn be used with a third parallel resistance laid off either on OR, Or or any other vertical line, as before, etc. Hence the graphic law corresponds to the most general case possible.

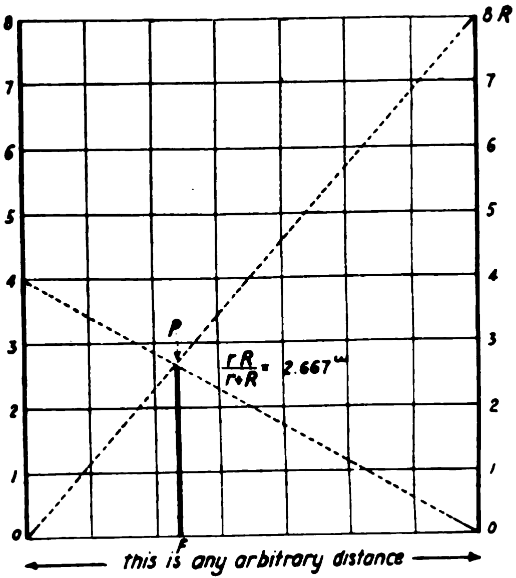


Figure 5—Chart giving the value of the multiple resistance of the two branches

If OR and Or were similar reactive ohms, i.e. from either condensers or inductors, the same laws would apply in figure 5.

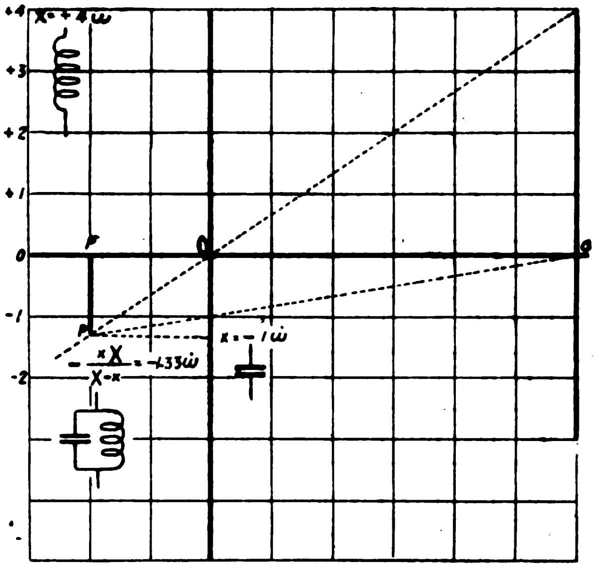
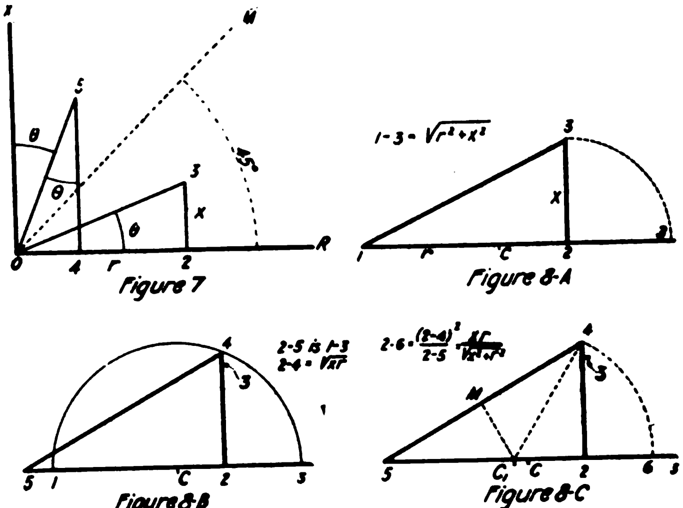


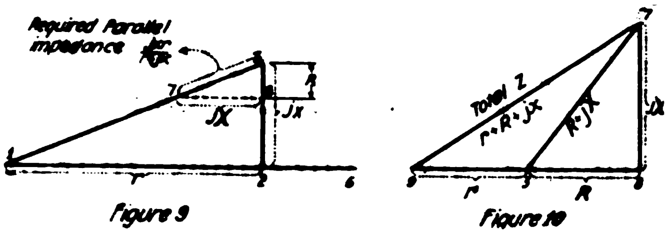
Figure 6—Diagram showing the value of the equivalent capacitive (or negative) reactance

As a matter of fact, the general graphical law holds true, with all combinations of condensers and inductors using the extended diagram with either Or or OR negative in the above construction, but it is mechanically inconvenient to apply, as can be seen by inspecting figure 6 where it is used. Here the process is exactly the same. Lay off OX the inductive reactance and ox, the capacitive reactance on opposite sides of the axis of abscissas O-o. Prolong the lines drawn through OX and ox till they meet at, say, P. The negative ordinate FP now represents the equivalent capacitive (or negative) reactance $\frac{Xx}{X-x}$. It is easy to see why FP grows enormously when ox approaches OX in value, i.e. when we approach the undamped resonant frequency of a branch resonant circuit. The values of FP go clear off any drawing-board to the



Figures 7 to 8 c—The two impedance triangles and graphical solution of the mixed reactances in multiple left; as OF enlarges proportionately to FP, and suddenly as ox and OX pass through parallelism, come back again as enormous positive values or inductive reactances to the extreme right of OX.

We are now ready to find the graphical solution of mixed reactances in multiple but cannot use either figures 5 or 6. Let the combined impedance of a reactance x and a resistance r in parallel be Z.



Figures 9-10—Graphical solutions of the impedance curio

$$Z = \frac{r^2x^2}{r^2 + x^2} + j\frac{r^2x}{r^2 + x^2}$$

where the equivalent resistance $R = \frac{rx^2}{r^2 + x^2}$ and the equivalent reactance $X = \frac{r^2x}{r^2 + x^2}$

The impedance triangles of r and x in series and in parallel are worthy of comparison; as their phases bear a simple and easily remembered relation to each other.

In figure 7 we have the two impedance triangles for comparison. The triangle 023 is the series impedance triangle and—omitting a constant factor for the moment—045 is the parallel impedance triangle. It has the same shape as 023, but displaced through the angle 305. It is evident that the parallel circuit behaves as if the resistance and reactance changed places; since, for this case

$$Z = \frac{xr}{x^2 + r^2}(x + jr)$$

instead of $Z = (r + jx)$

The graphical problem is to get the geometrical value of

$$Z = \frac{xr}{\sqrt{x^2 + r^2}}$$

The solution is given in figures 8a, 8b and 8c: In figure 8a we lay off r equals 1-2 and x equals 2-3. Then swing 2-3 around as a prolongation of 1-2. The line 1-3 is of course $= \sqrt{r^2 + x^2}$. Figure 8b is the same as 8a but with c as the midpoint of 1—3 as a diameter we describe a semicircle and prolong the line 2-3 until it intersects this semicircle at 4. The line 2-4 is a mean proportional between 1-2 and 2-3 or between r and x. Hence we now have $2\text{-}4 = \sqrt{x\,r}$. In figure 8c we now combine 1-3 and 2-4 so as to get $2\text{-}6 = \frac{xr}{\sqrt{x^2 + r^2}}$ which is our answer—by proceeding as follows:

Lay off 2-5 equal to 1-3 and join 5 to 4. Erect a perpendicular at the midpoint M of 3-1 and let it cut the line 2-5 at C. With C′ as a center and radius equal to C′-4 describe an arc cutting 2-5, prolonged, at 6. The line 2-6 is the required geometrical measure of the combined impedance. This is surely different from the methods used in figures 4 and 5! It is far easier to do than to talk about, however!

In figure 9 we have the promised final graphical solution of the impedance between A and B in figure 1 by the application of figure 8a to an impedance triangle x + jr corresponding to the triangle 045 in figure 7.

In figure 9 we use the distance 2-6 found in figure 8c and lay it off as 3-7 along the line 3-1 in figure 8a, where 3-1 represents $\sqrt{r^2 + x^2}$ Hence 3-7 equals 2-6.

The ratio of $\frac{2\text{-}6}{3\text{-}1} = \frac{xr}{x^2 + r^2}$ and when applied to x + jr, gives the parallel impedance triangle, if we remember that the combined resistance R and reactance X are interchanged in phase relation, as shown in figure 7, when compared to the series impedance triangle 023.

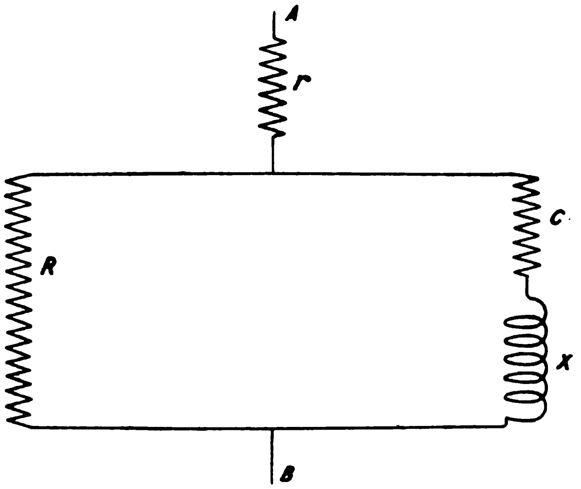


Figure 11—Circuit used in Campbell's solution

So we take the portion 3-8 from 2-3 or x and call it R and similarly take the portion 7-8 parallel to 1-2 or r and call it j X. Thus the "parallel Z" = R + j X and in figure 10 by adding the series resistance r to the impedance triangle 387 we have solved our problem completely by graphical methods.

Now we are ready to take these results on the general resistance, r, and reactance, x, in series or parallel and apply them to figure 10 which is to be considered as representing the arrangements shown in figure 2.

It is the line 7-9 in figure 10 whose paradoxical behaviour we have been examining in figure 2. The greater the value of r the greater the departure from the usual behaviour of parallel impedances.

In closing this article I wish to call attention to a serious error on the part of Mr. A. Campbell who gave in the London Electrician for May 6, 1910, p. 157 a solution of the circuit shown in figure 11. He gives between A and B the impedance for a resistive inductance CX shunted by a pure resistance R and in series with a pure resistance r. It is in my notation given as

$$Z^2 = \frac{[r\,(R + C) + RC]^2 + (R + C)^2\,X^2}{(R + C)^2 + X^2}$$

On inspecting this formula it looked unsound, and I became certain of its incorrectness when C is put equal to zero, when we have the case we have just investigated.

According to Campbell, for this case

$$Z^2 = \frac{r^2\,R^2 + R^2\,X^2}{R^2 + X^2}$$

whereas the correct formula is

$$Z^2 = \frac{(RX^2 + R^2r + r\,X^2)^2 + R^4\,X^2}{(R^2 + X^2)^2}$$

The absurdity of the previous formula is evident if we let r equal 0, in which case we get a true result

$$Z^2 = \frac{R^2\,X^2}{R^2 + X^2}$$

but by adding r in series to this true result we do not get Campbell's shorter formula! The correct general formula for figure 11 is

$$Z = \frac{(R + C)\,CR + RX^2 + (R + C)^2\,r + yX^2 + jR^2X}{(C + R)^2 + X^2}$$

and solution for the critical points of this equation is in progress.

—O. C. R.

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EXPERIMENTERS' WORLD

Views of readers on subjects and specific problems they would like to have discussed in this department will be appreciated by the Editor

Operating Suggestions for the Radio Amateur

By J. H. Tolley

FIRST PRIZE, $10.00

THIS prize contest which THE WIRELESS AGE announces on "Operating Suggestions for the Radio Amateur" is timely and should result in a benefit to all stations if even only a few of the suggestions brought forth are tried out by station owners. As pointed out in the contest announcement, a great percentage of the amateurs operating stations either have given the interference problem little thought or are indifferent to the interference and inconvenience they may be causing to brother amateurs or professionals by unprofessional methods of operating.

Enough has been said of the necessity of proper tuning of the transmitter and we will confine our remarks to the handling of it after the proper adjustments have been made. In the first place before attempting to do any telegraphing the student should know the code thoroughly, the practice work should be done on a buzzer set and continued until there is no hesitation in making any character desired. The spacing between letters and between words is very important. If the student will bear in mind that he is in fact writing when he telegraphs and strives to make his characters spaced exactly as they would appear in writing or in print, it will result in fewer twenty-eight letter words at the receiving station. The study of the proper spacing is as important to the beginner in telegraphy as is the study of tempo to the beginner in music. Until the student is able to take a newspaper and send a hundred or two hundred words without hesitation or stumbling and with uniform spacing between words he should not attempt to turn loose his skill upon the much abused ether. I have been chuckling lately when I see articles in the newspapers and magazines referring to strange signals undecipherable being heard and the possibility of their being signals from Mars. Confidentially, I feel sure that they are caused by some of the new crop of amateurs who reverse the process and learn the code last. Even after learning the code it is an excellent plan to do but little sending and much listening. This is the best way, too, in which to attain efficiency in receiving. Pick out some station which operates in a short business-like way and avoids saying or repeating the same thing over and over. Study his style of handling messages or conversation and note how he gets over the ground in comparison with the operator who insults your ability to receive by repeating numerous times.

Telegraphing is the same thing as carrying on a conversation by word of mouth providing always that the static or interference is not breaking it up, and numerous repetitions or lengthy explanations are as unnecessary there as in conversation by word of mouth. The international abbreviations used in handling traffic should be committed to memory, at least the ones in most common use, so that the meaning of each will be recognized immediately upon hearing it. A copy of this list should be posted in a convenient place also, so that a glance will be sufficient to read any abbreviation heard and not recognized. If this plan is followed out, it will be but a short time before the entire list is committed to memory.

It is not necessary that you do some transmitting every time you sit down to the apparatus either. Make it a practice to listen for at least five minutes after sitting in before you do any sending. This will give you an idea of what the conditions are like, and if the air is already crowded there is little use in getting in yourself and adding to the confusion. Just what idea underlies the practice of some stations calling others frantically and insistently only to say "Good evening, how do you get me," when they receive an answer, I am unable to say, but note that it is common practice. It would seem that if there is nothing more important to transmit it would not justify the interference and hard feeling caused. If the need of practice is felt, why not do it upon

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the buzzer set instead of turning it loose upon the heads of those engaged in trying to get through legitimate information.

When sending messages, use the regulation form. This will help the operator on the receiving end, as he is probably expecting that you will do this, and the use of Bohemian methods will probably decide him that he will see less of you until you learn something about the game. The old timers especially dislike to work with revolutionary newcomers and if you wish to stand in with them and become one of the gang with a standing, copy their style and graduate from the ranks of those responsible for the invention of the sandwich and the stove cover.

Avoid the long call. A half dozen times is as good as a million if the other fellow is not getting you, and if he is getting you, one is sufficient. In signing your own station-call the same advice applies. If he is getting you, once or twice is enough. If he is not getting you a million repetitions do no good. Above all do not be one of the expert alibi artists. If you fail to get what is sent you ask for repetition and stop there. An explanation comprising two hundred words of why you did not get the twenty-five words sent you is uncalled for and of no interest to the operator at the other end. The only thing of interest to him is the fact that you wish him to repeat. This last applies not only to amateurs but to a great many operators earning their livelihood as such. They waste their own time and others by going into lengthy explanations as to why they are asking for repetition, sending seventy or eighty words of this useless stuff when the message missed is possibly of only twelve or fifteen words and could be sent over a half dozen times while they are establishing an alibi.

If you know that your speed in receiving is limited to about fifteen words per minute, you invite trouble by sending to another station at a rate of twenty-five words per minute for the reason that in all probability he will answer you at the same rate of speed and you will then be called upon to exercise your ingenuity in establishing an alibi, which an incredulous and contemptuous operator at the other end clearly sees through. Try always to make good copy, and follow the professional form of writing messages; that is, place the message number, operator's signs, check, date, address, etc., on the sheet in the same manner as is done in professional work. It is bad practice also to write too close behind the sender for the

(*Continued on page* 41)

Operating Suggestions for the Radio Amateur by "Sparks"

By H. S. Pyle

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ing, the time is fast approaching when the interference problem will grow to such a state that the handling of traffic at any distance on two hundred meters, will be absolutely impossible, whereas it is merely difficult now. The only method of side tracking such a condition of affairs, lies in efficient control of traffic and operators in such a way as to reduce interference to the minimum, and such regulation had much better come from the amateurs themselves, rather than from a disinterested government committee. Control *must* be had, and it is the purpose of the writer to endeavor to point out a few ways in which such control may be had, from experience gleaned from eleven years of amateur, commercial and government radio-telegraphy operating.

The chief cause of interference with long distance work on two hundred meters, seems to be from what is known as "local" interference; that is, interference within a few miles of the station attempting the distance work. Generally the cause is the use of too much power, by the interfering stations, for local work. The law distinctly states that—"the least amount of power necessary to effect reliable communication shall be used—" and amateurs are *not* exempt from existing laws. As a rule this use of surplus power is merely thoughtless, or the station may not be equipped with any method of reducing power. This should by all means be done, either by the use of impedance coils, or what is a far more satisfactory method, the use of a low power transmitting unit, designed only for short range local work. Several excellent articles describing such a set have appeared in recent issues of the WIRELESS AGE and any of these, if operated on a shorter wave than two hundred meters, will make an ideal local transmitter, with non-interfering characteristics. The use of a shorter wave length than two hundred meters, has not been as fully emphasized as it should be in the amateur world.

It is of great advantage to commercial and naval stations to be provided with a means of changing their wave length and no up-to-date installation will be found without some such wave-changing device. If it is desirable to use an antenna of 160 or 180 meters natural wave length, the use of a shorter wave cannot be effected efficiently, but in local work, efficiency need not be the prime consideration as distance is not the object in view. In such cases, then, the series condenser is wholly feasible, and it is suggested that the amateur operator, particularly in cities where a large number of good stations are located, read up on series condensers and their proper usage, in one of the many excellent handbooks obtainable from the Wireless Press. A wave as low as one hundred meters will be very satisfactory for all communication with other stations in the same city, or even nearby neighboring cities. The Canadian amateur before the war, was restricted to fifty meters, yet their stations, while hanging up no real distance records, did good work on this wave. Use a wave at least twenty-five meters below two hundred, and as little power as necessary to "get across" and if you are sharply

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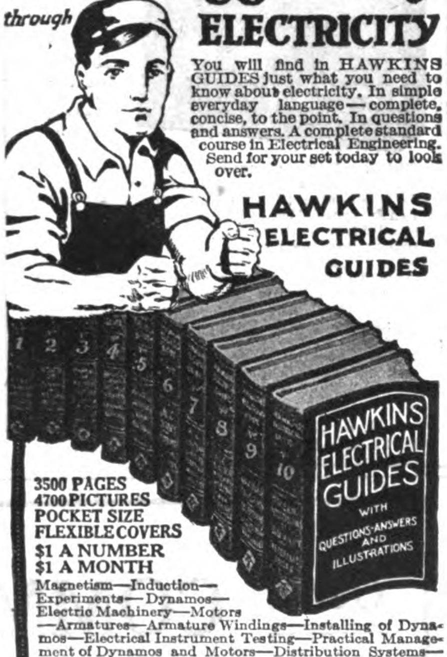

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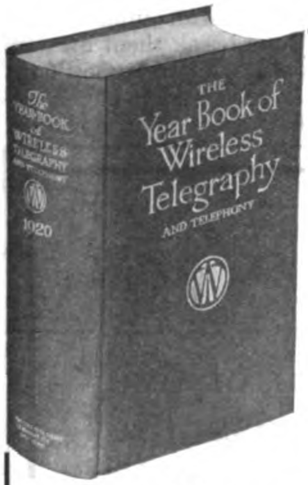

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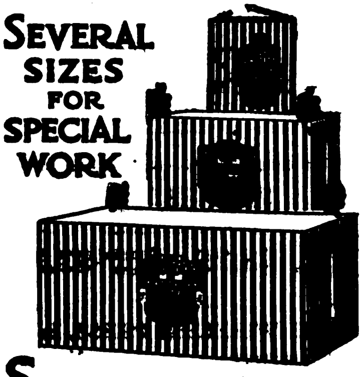

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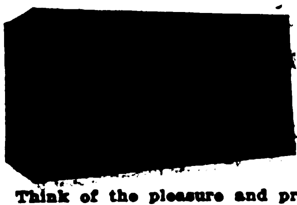

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tuned, as you should be, not nearly so many complaints of interference will be logged against you. It is a simple matter, should you want to talk over a fishing trip with your friend a few blocks away, to call him on two hundred meters, where he is very likely listening, and tell him to come down to a hundred and fifty and listen for you.

Leaving the question of wavelength and power, much can be done with the actual handling of the key—or rather not handling. First, be certain of what you are about to say, before you attempt to make it on the key. Don't just "ramble along" using a great deal of unnecessary words to say some simple thing. In this connection it cannot be too strongly urged, that the amateur operator become familiar with a large part of the Phillips code, which greatly simplifies and shortens transmission. Calling a station, seems for some operators, to be almost a rite. A common occurrence is the use of the attention sign three or four times before commencing a call, and following that with a long winded call for the station, "DE" several times and a long string composed of your own call letters—usually a couple of "AR'S," "K's" and anything else which may catch the operator's eye while his glance wanders over the code chart follows.

It is surprising how few amateurs, comparatively, know the correct forms for calling, acknowledging, answering and sending a message. This is a great cause of unnecessary interference. The conventional methods for each of these transmissions take into consideration the least number of parts necessary to intelligently communicate, eliminating all unnecessary signaling.

A further cut in the conventional call, which specifies three times for each group of call letters (station called and calling station, preceded by attention sign and separated by "DE") may be made by shortening the repetition of call letters, for nearby stations, putting in a short snappy call and then quitting. If the station called is there and not otherwise occupied he will answer such a call as readily as a long drawn one, which causes all listening operators to sit back in disgust and think of you as a "ham." It used to be possible to learn efficient methods of operating by listening to the old commercial and naval men handle business, but the commercials are no more and the navy has found it necessary or seen fit, to make almost all of their stations student training stations and nothing can be learned from them. In fact it is advisable not to pattern your transmission after that which you hear today, but by far the best method is to obtain a copy of the regulations now in force governing radio communication, which may be obtained from the Superintendent of Documents, Washington, D. C. These contain all the forms authorized for use and practice of them on a buzzer with actual message forms as reproduced in the book is the best possible training to carry into your actual operating.

One rule of the utmost importance is perhaps the most generally disregarded of them all. I refer to the provision for listening in before transmission. It is obvious that if a station is engaged with another, he cannot handle your message at the same time, and it should be the amateur's "religion" to listen a few moments before calling a station. He may be copying a station whom you cannot hear—wait long enough to make certain that he is free, then put in a short call. Remember, too, that local men may be copying long distance stuff unknown to you and you may break them up with some inquiry of a totally superfluous nature. If you are asked to stop sending in such a case, don't become

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grouchy—give the other man a chance. Try to get through with your local chatter by nine P. M. Almost every one can do this, and it is becoming generally recognized that the hours after that are for long distance work. Any amateur who persists in "chewing the rag" needlessly long after nine o'clock may soon find himself held in much scorn by other amateurs, which may result in more stringent action from a local club.

In closing, the whole "sermon" may be summed up in the well worn, but nevertheless suitable phrase: "Give the other fellow a chance."

Radio Amateur's Ten Commandments

By H. P. Roberts

THIRD PRIZE, $3.00

YE SHALL reap what ye sow.

2. Ye shall at all times "Listen In" before using that transmitting set of thine.
3. Transmit not for the purpose of hearing thy spark, unless thou connect not thine antenna.
4. A "Ham" will not enter into the kingdom of oscillation heaven, therefore be ye not a "Ham."
5. Write ye first upon a manuscript that which thou wish to transmit.
6. Ye shall keep a systematic record conscientiously, which shall be known as ye "Log."
7. Ye shall pound with thy fist clearly and distinctly without undue haste.
8. Ye shall at all times be courteous, remembering that some of the weaker sex, which God hath given us, do likewise understand that which thou sayeth.
9. Ye shall have thy transmitting set ready to instantly answer when thou art called, neither shalt thou depend upon thy memory, for it be mortal and subject to mistakes, wherefor shalt thou copy all messages of length.
10. Thou shalt transmit with proper form, waves and power prescribed by thy government.

Our text for today, brethren, is upon the ten commandments and is as follows:

Concerning commandment 1: If you wish consideration and lack of QRM, when you want to work long distances, give the same consideration to the other fellow when he wants it. If you continually "99" some other fellow, and think you own the air, you will be regarded as a ham-bug, and be treated so by others.

Concerning commandment 2: If you call a number on the telephone and the operator tells you the line is busy, you hang up and wait. When the radio circuit is "busy," just "hang up and wait" for your turn. You will in the long run get your message off quicker, for when the other fellow is through, he won't interfere with you.

Commandment 3 states that this "other fellow" is not at all interested in hearing your spark squeal test signals; he really is not in the least concerned with how clear your spark sounds, so why not just take off your antenna clip, when you want to "fuss" with it.

Commandment 4 warns you not to be a "ham," and you know you don't want to be one. If you can't copy 20

A
Q S T de ACE
E

LET'S SING
(TUNE Battle Hymn of the Republic)
Mine ears have heard the signals
From a dozen different lands
From Greenland's icy mountains
To Sahara's burning sands
From the land of cherry blossoms
To where Mount Sorata stands
And I've learned a thing or two.
CHORUS
Q. R. X. I'm going to tell you
Q. R. X. I'm going to tell you
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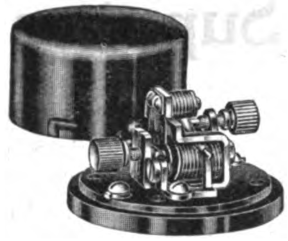

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words a minute, and John Jones is always in the habit of sending at that rate, don't try to talk to John Jones; talk to Jack Smith, who can only send ten words himself, or get busy and practice your speed tests on a buzzer. Don't use the poor overworked ether, to learn the code on.

If you will heed commandment 5, and write on a blank, first, what you want to say, and how you want to say it, you will save much time in transmitting it, and also have a permanent record of what you did say to Jack Smith on the night of December 1, 1919, when "8XYZ" in Bingville, writes to you later, saying he heard your signals on that night, and wants a verification.

Commandment 6 tells you to try and operate your station as nearly as possible like a commercial station. Commercial operators must be efficient, and if the amateur will try to follow in their footsteps, they will be much better operators, and accomplish a good deal more.

Commandment 7 simply tells you to use "horse sense"; to take time enough to send each letter, each dot and dash, distinctly, and *not* to send so quickly and so haphazardly as to require repetition of your whole message, and loss of time. Again, follow in the footsteps of the commercial man, and listen to how he sends. He was once an amateur and he has simply had more practice and experience than you. For instance, watch how he sends his C's. Do you notice how he holds on to the first dash much longer than the second: That is not merely the operator's "fist," but it is his attempt at clearness, to make a distinction between the letter C, and two N's sent right together. He has many other little tricks which it will pay you to learn. Listen to them next time you hear him.

Commandment 8 advises you against losing your temper. We are all of us trying to coach the beginner along, and when he does get on the circuit, and is doing his best, and necessarily taking more time than you or I, just when you or I want to do some work ourselves, be a little patient. You and I were as bad or worse than he, at one time. *Be courteous—always.* You'll find it will get you much farther. Besides it may be some good looking young lady, trying to master the code, and then think how you'd feel if she looked you up in "Hoyle."

Commandment 9 gives us good advice. When you are ready to answer someone, and the "line" is OK, just remember that every other fellow also knows at that moment that the "line" is not busy, and he is liable to be getting ready to send, so don't throw your switch, and then start your rotary gap, and make other little adjustments before sending; while you're doing all this, some other fellow may have started sending, without your knowledge, for your switch is on "transmitting" side. Don't throw your antenna switch, unless you are all ready to hit the key, the instant it is thrown.

Commandment 10 is one we must follow. It is not optional. Uncle Sam requires us amateurs to use *not more than 200 meters*. Don't use 205. He requires us who are within five miles of a Government station to use not more than ½ kw. Don't use 17/32. He requires the rest of us to use not more than 1 kw. Don't use 1 1/10. Obey the law. Don't give the radio amateur a bad reputation. It reflects on us all, and when we want the Government to help us, we want to show that we have treated the Government square. Do you know that your government is giving you privileges far beyond the hopes of amateurs in other countries? *Be on the level!*

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The subject for the new prize contest of our year-round series is:

"A FEW CAREFULLY THOUGHT OUT SUGGESTIONS CONCERNING THE DISTRIBUTION OF WAVE LENGTHS AND USE OF POWER FOR LOCAL, INTER-CITY AND LONG DISTANCE TRANSMISSION AND POSSIBLE METHODS OF ACCOMPLISHMENT."

Closing date, September 1, 1920.

Contestants are requested to submit articles at the earliest practicable date.

Prize Winning Articles Will Appear in the November Issue.

As a result of a long series of more or less formal inter-allied radio conferences and, more directly, as the result of the deliberations of a Wave Length Regulation Committee appointed by the Secretary of Commerce, it is very likely that ere long a new radio law will come into existence which fixes the range of wave lengths for amateur stations between 175 and 250 meters. It is to be noted that, generally, all spark stations will be held between 175 and 220 meters and that 220 meters to 250 meters is to be used strictly for undamped wave transmission and modulated undamped wave transmission.

Due to lack of appropriation, it has never been possible for our Department of Commerce to exercise strict control over amateur installations. As a result amateurs have, in the past, had a band of wave lengths equal or superior to that which is to be offered by the proposed law. Should this law be passed, it is very likely that it will be very much more rigidly enforced. Spark stations would then fall in a very much narrower band of wave lengths than has been the case. Interference, even with the present "free for all" arrangement has become a very difficult problem and will soon become a very much more difficult one. This has been apparent to a great many amateurs for a long time, and it is gratifying to note the keen interest which has been taken by amateurs everywhere in recent WIRELESS AGE *prize contests, which have directed amateur thought toward the limiting of interference by self regulation, self control and practice of a little unselfishness.*

PRIZE CONTEST CONDITIONS—Manuscripts on the subject announced above are judged by the Editors of THE WIRELESS AGE from the viewpoint of the ingeniousness of the idea presented, its practicability and general utility, originality, and clearness in the description. Literary ability is not needed, but neatness in manuscript and drawing is taken into account. Finished drawings are not required, sketches will do. The contest is open to everybody. The closing date is given in the above announcement. THE WIRELESS AGE will award the following prizes: First Prize, $10.00; Second Prize, $5.00; Third Prize, $3.00, *in addition to the regular space rates paid for technical articles.*

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New License Tests

CHIEF Radio Inspector L. R. Krumm announces that after July 1st, applicants examined in his office for commercial radio operator's license will be tested in their transmitting ability in sending Continental Code.

Applicants for Commercial First Grade Operator's licenses will be required to send 100 satisfactory code characters in succession in a five-minute test at a 20-word-per-minute speed.

Applicants for Commercial Second Grade Operator's license will be required to send 60 satisfactory code characters in succession in a five-minute test at 12 words per minute speed.

The transmissions by the applicant will be received by the examiner and will also be graphically recorded on a tape recorder as a check against transmissions in case of doubt.

Radio schools training men who expect to take these examinations are requested to prepare their students for this transmitting test and include a test therein before they give the student the usual letter certifying that they have satisfactorily passed the course, and for which the applicant is allowed a 10% experience mark in this office. The transmitting test given the applicants will include characters, numbers and signals of all kinds used in the usual transmission. The conditions under which the applicant is tested are made as nearly similar to actual conditions as possible, the applicant hearing his own note in his receivers and otherwise working under no unusual conditions.

After July 1st, examinations for Commercial operator's licenses will be given on Mondays, Wednesdays and Fridays only, except on holidays. The examination is given at 9 A. M. in Room 603, Custom House, New York, and applicants should appear promptly with whatever documentary evidence they may have indicating their radio experience and training. Reservations for places should be made in advance as the facilities are limited and it is expected will be completely utilized on each day.

The Radio Club of Hartford, at its monthly meeting, decided that the first annual radio convention of southern New England would be held in Hartford. A committee was appointed by Vice President Edward L. Belknap, presiding, to decide upon the date of the convention and make all necessary arrangements. The committee, consisting of Hiram P. Maxim, chairman, Louis W. Batchelder, Walter B. Spencer, K. B. Warner and J. L. Belknap, will report at the next meeting.

David Moore of Farmington, a charter member of the club, was present at the meeting and told of his experiences as a ship's radio operator during a trip around the world, from which he has just returned. He left New York last October, going through the Panama canal and then to Japan,

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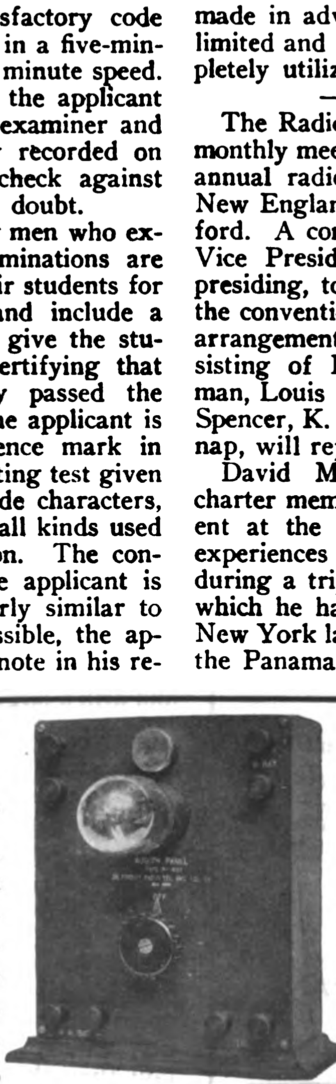

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the Philippines, Singapore, Java, Sumatra and the Cerebres Islands. He returned by the way of the Suez Canal, visiting Malta and Gibraltar.

At the recent meeting of the Lynn, Mass., section of the Essex County Radio Association, the following officers were elected: President, Roger Osborn; vice president, Harry L. Sawyer; treasurer, Herbert Young; secretary, Herbert I. Stickney; advisory board, Roger Osborn and Kendall Redfield.

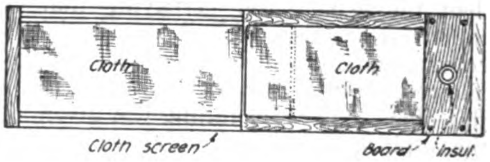
Plans were made to hold a dance soon, using music from a wireless receiver and loud speaking telephone to be demonstrated also at the coming General Electric field day.

F. Clifford Estey outlined the plans for the coming season and requested that all Lynners interested in radio work get in touch with the secretary. Mr. Estey is president of the Essex County Association and urged amateurs to send wireless messages of interest to newspapers and magazines to the secretary by wireless and also to keep in touch with members by wireless.

A Simple Lead-In

By Emil Otto

ALL amateurs living in the city have experienced the difficulty of constructing a suitable lead-in. The erection of the antenna seems to have been a simple problem when compared to the trouble of bringing the wire lead-in into the room. Landlords balk at having their walls and sashes drilled full of large holes and think they have gone far enough to allow the amateur to erect an antenna. Drilling window panes is a further task, as anyone will find if he tries.



After working some time with the problem, I came upon this solution: Upon a narrow screen such as is used for ventilation with a cloth netting instead of the usual wire, fasten a small board at one end with wood screws and drill a large hole for your entrance insulation. For insulation use a medium electrose tube for transmitters and a porcelain tube for reception. Hammer a small nail under the screen after it is in the window and it will not fall when the sash is lowered.

This screen has many advantages. It is cheap, portable, adjustable to any window, can cause no comment from the landlord, and above all, functions as it was intended and gives the operating room draughtless ventilation which is perhaps more important than the lead-in itself.

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Operating Suggestions for the Radio Amateur

(*Continued from page* 32)

reason that if a mistake is made in sending it is written down and must then be erased. Writing a word or two behind the sender will result in better looking copy.

Avoid joining the ranks of the "QRA'S." They are already overcrowded. I refer to the operator who whenever he hears a strange call must open up and inquire "QRA O M." He is probably not O M to you anyway, being a stranger. Up to date call lists are to be had at a very low cost and reference to one of these is to be preferred to the QRA method.

Don't copy the style of the operator who affects a swing in his sending. It is odd of course, and attracts attention, but so do the guests at Mattewan and many other things which most people are shy of. *The best method of finding out what to avoid is to take note of what causes you to froth at the mouth when you are trying to get through something and are prevented by other stations interfering. Take careful note of what might have been eliminated by them and avoid just that yourself in the future.*

A word of warning in conclusion. The Government regulations are not strict and interference is bad. If conditions continue to grow worse, it is an unavoidable conclusion that the Government will take steps to improve matters and whatever form such legislation may take, it will surely place further restrictions upon amateur transmission. So, in justice to yourself and the many amateur station owners who strive to improve matters, get behind offending stations when you locate them, and if you cannot induce them to mend their ways by argument, apply a little pressure. Exclude them from your clubs and meetings; refuse to work with them, and if necessary explain matters to the government inspector and ask him to

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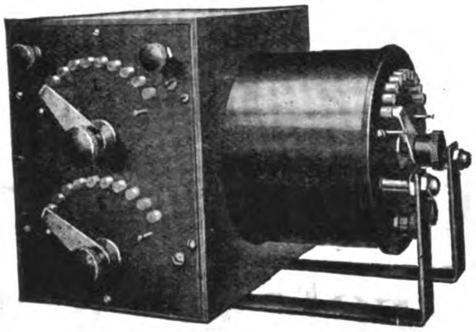

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get behind the unmanageable one. In doing this, you will be doing it as much for yourself as anyone else. If you do nothing about it but let the newcomers play as they will, you also will be partly to blame, when stricter laws take from you some of the privileges now allowed.

Close Your Ground Switch

Radio amateurs should never fail to close the ground switch when leaving their apparatus. For an aerial attracts lightning and a thunder storm may come up when the operator is absent. If it does, and the lightning is led into the house, the amateur will find all his apparatus out of business, wrecked beyond repair, to say nothing of the responsibility of the house being set on fire.

Queries Answered

Answers will be given in this department to questions of subscribers, covering the full range of wireless subjects, but only those which relate to the technical phases of the art and which are of general interest to readers will be published here. The subscriber's name and address must be given in all letters and only one side of the paper written on; where diagrams are necessary they must be on a separate sheet and drawn with India ink. Not more than five questions of one reader can be answered in the same issue. To receive attention these rules must be rigidly observed.

Positively no questions answered by mail.

H. S., Brooklyn, N. Y.

You should be able to secure transil oil for use in your oil condenser from the Service Department of your electric lighting company.

* * *

F. P. B., Portland, Oregon.

Wiring diagram of a double rectifier and filter enabling the use of alternating current for plate supply of vacuum tubes, as well as dimensions of units used in this filter, has been printed in recent issues of this magazine. We hope to be able to publish in the near future an article giving constructional data to cover a step-up transformer 110 to 500 volts.

The current capacity of any rectifier tube is limited. If your rectifier tube will supply, say, 20 watts at 500 volts and your audion takes only 10 watts in the plate circuit, it will be possible for you to use two audions with one pair of rectifier tubes. If you use 4 audions you will need 4 rectifier tubes; 6 audions, 6 rectifier tubes, etc.

The more tubes used, the greater will the range be. Usually it is not the practice to use more than six tubes in multiple. Where tubes are connected in multiple, all grids are connected together, all plates together, and with the commercial type of vacuum tube, all filaments to the same lighting member with a separate rheostat for each filament.

Copper wire is best for an amateur aerial. Amateurs generally seem to use phosphor bronze. Phosphor bronze wire was originally used in wireless installation because of its great tensile strength—it being required that once an antenna had been erected, it would maintain its position permanently, regardless of heavy weather. The conductivity of phosphor bronze wire, however, is at best only about 75 per cent. of that of copper. In-as-much as the amateur is not particularly concerned about the continuity of operation of his outfit and in-as-much as his spans are usually short ones, copper wire is entirely satisfactory. For 200-meter work a "T" antenna is good, if you are so located that it is possible for you to erect one. Next to this, perhaps the best antenna for general amateur use is the inverted L type, although it will usually be found that greater range is to be had with a vertical wire antenna, than with either of the above. For a given fundamental wavelength the vertical wire gives the greatest effective height.

* * *

R. D. McC., East Palestine, Ohio.

You may obtain condensers suitable for use in the super-heterodyne receiver as described in the February Wireless Age from the Adams Morgan Co., Montclair, N. J. Condensers supplied by this concern have a capacity of .01 mf. and an insulation resistance upward of 25,000,000 ohms.

You may use any type of detector tube as the detector in the above mentioned outfit. This also applies to the oscillator, but considerable care will need to be taken in the selection of the tubes for the amplifier for a noisy tube in the first stages of the amplifier will cause considerable trouble, due to the amplification of the noise as it passes from stage to stage.

* * *

M. M., Toronto, Canada.

N S N are the call letters of the U. S. S. Conner. W B F is the call of the Tropical Radio Company's station at Boston, Mass. We are unable to locate stations "P T A" and "V A V."

* * *

C. R. T., Scranton, Pennsylvania.

We presume that if you are going to build a lose coupler to operate on wave lengths between 1,000 and 25,000 meters, you expect to use a regenerative receiver of some type. The design of a receiving transformer for use with a straight detector is usually somewhat different both mechanically and electrically. If you will let us know just what type of outfit it is you have in mind, we will be glad to make suggestions as to its construction.

* * *

W. A. Clutier, Iowa.

If you intend to use the 250-ft. antenna for receiving only, the Radio Inspector will have no objections to make. If you should desire to do transmitting, it will be necessary for you to put up an antenna which is slightly under 100 feet in length.

* * *

Captain A. G. B., Edinburgh, Scotland.

With reference to the article by Mr. Charles R. Leutz in the January Issue which describes a detector and four-stage resistance coupled amplifier, we regret to say that the diagram, as well as our correction became somewhat mixed. The alteration as suggested in the April issue would short the "B" battery, as you have stated. It was Mr. Leutz's intention to use the same system of obtaining reaction as he described in his long wave receiver article printed in the September issue. As you have stated, and to use your words, the connection should be as follows:

"Delete connection of negative terminal of "B" battery direct to positive terminal of filament battery and substitute for it a connection from negative terminal of "B" battery to the terminal marked "wing."

The condenser referred to at top of page 26 of the January issue as C2 is that one which is placed in shunt to the plate resistance of the detector tube and therefore, as stated by Mr. Leutz, allows the high frequency oscillations to pass around the resistance, but, being generally of such small value as to force the audio frequency pulses through the resistance itself. We would be glad to learn of work which you are no doubt doing with circuits of this type.

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Pacent Electric Co., Inc., New York City
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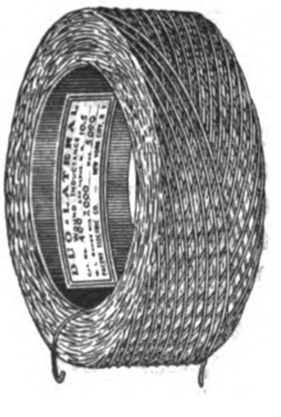

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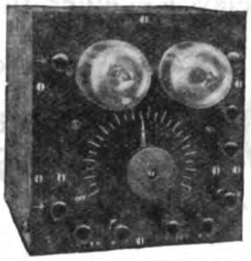

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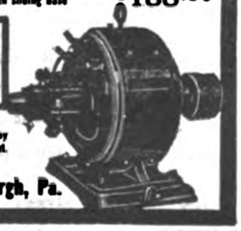

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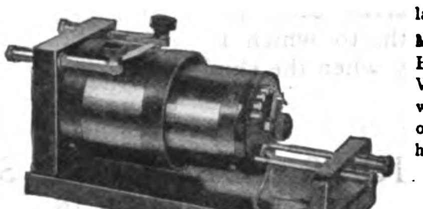

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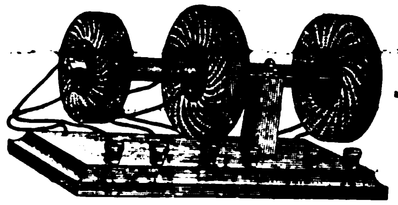

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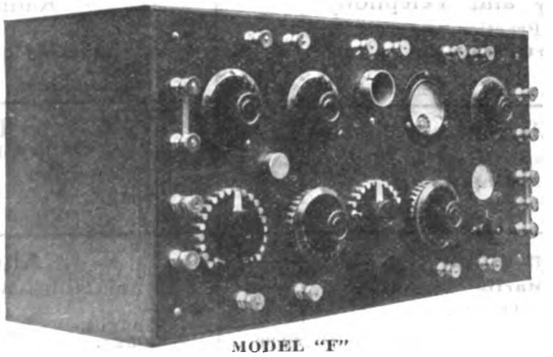

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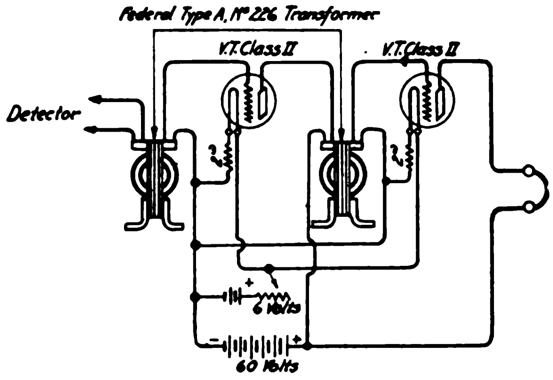

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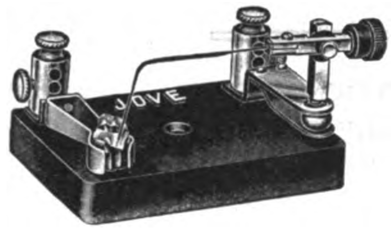

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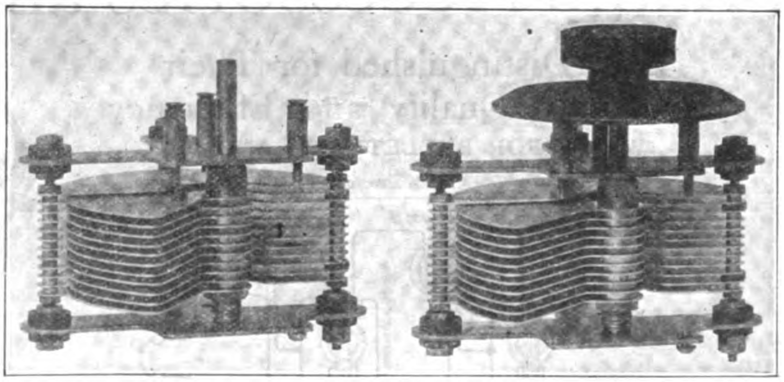

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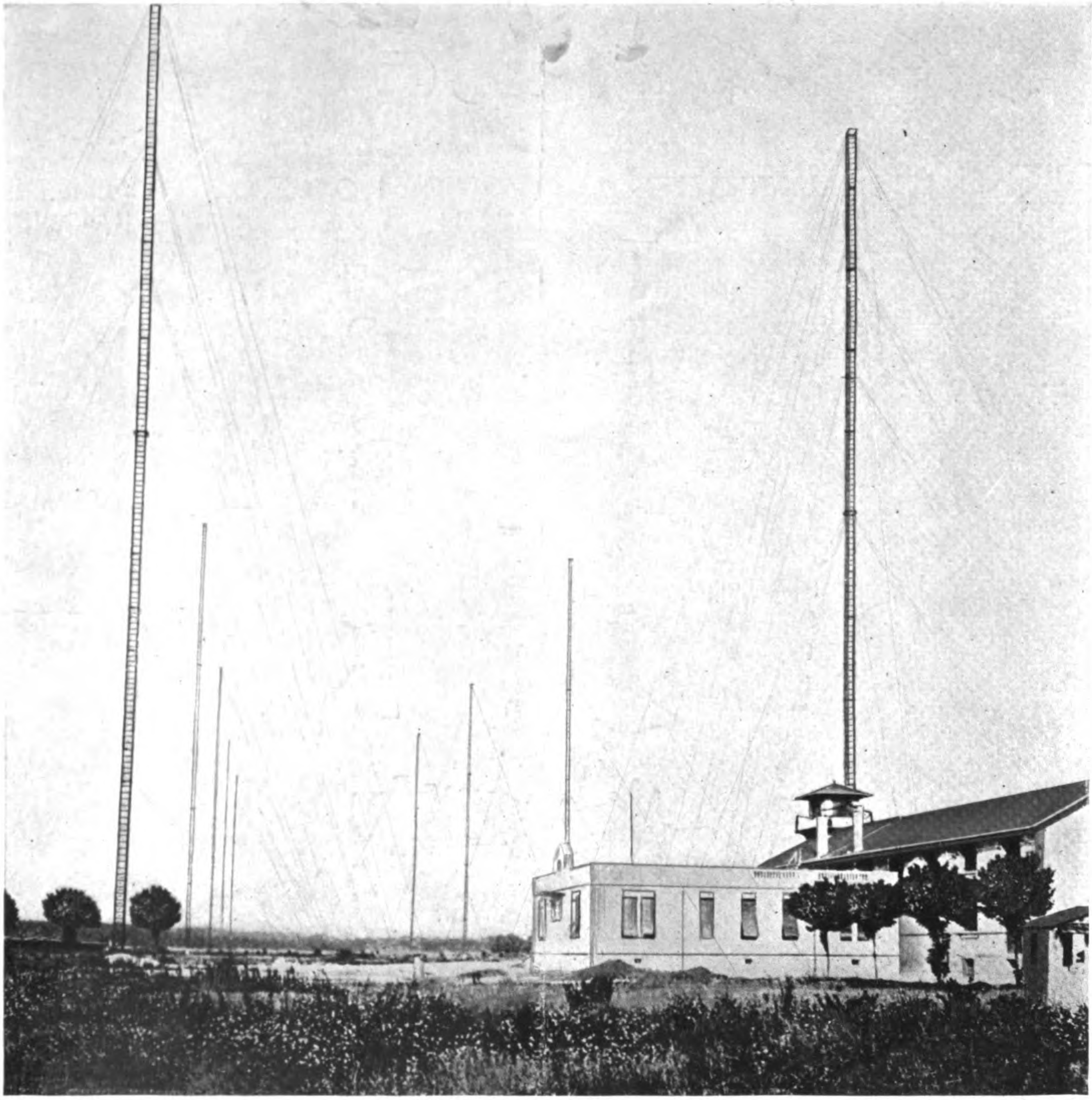

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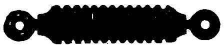
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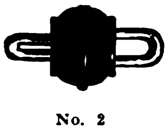
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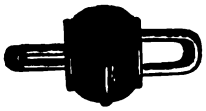
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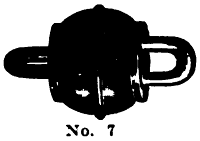
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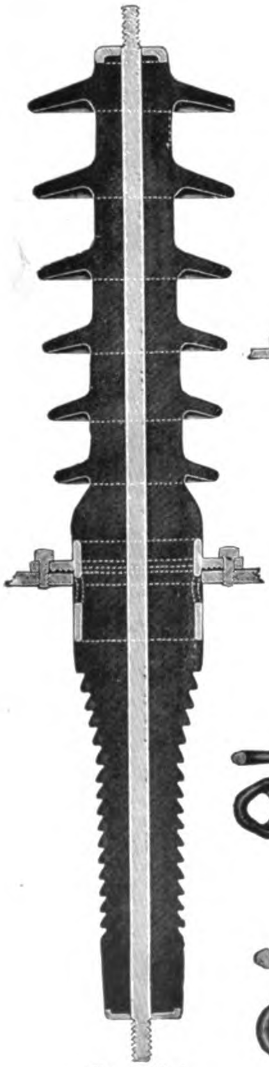
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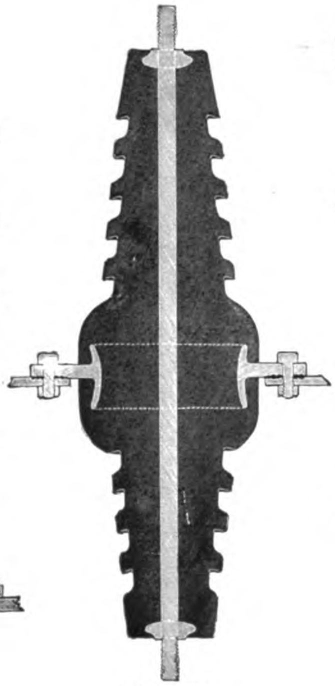
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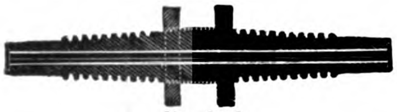
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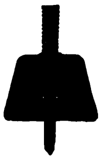
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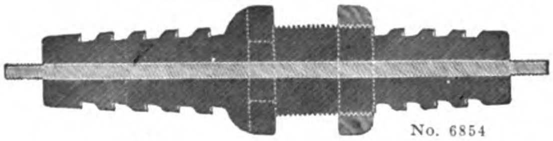
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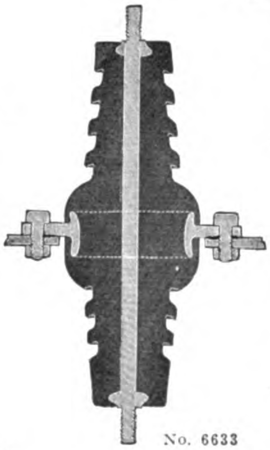
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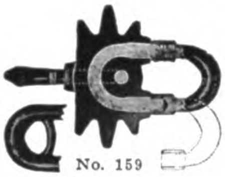
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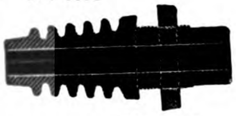
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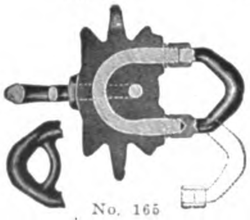
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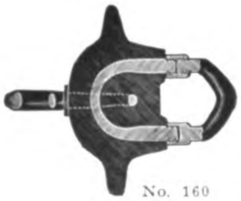
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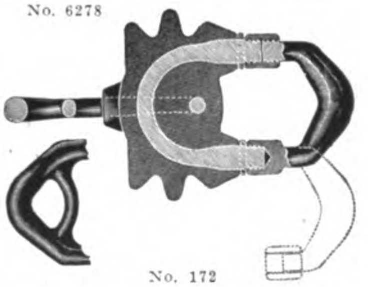
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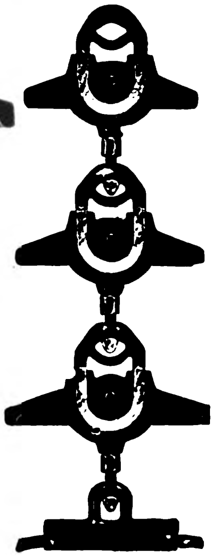
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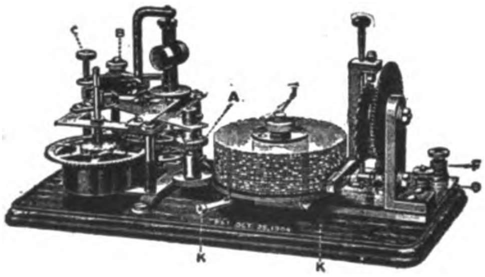

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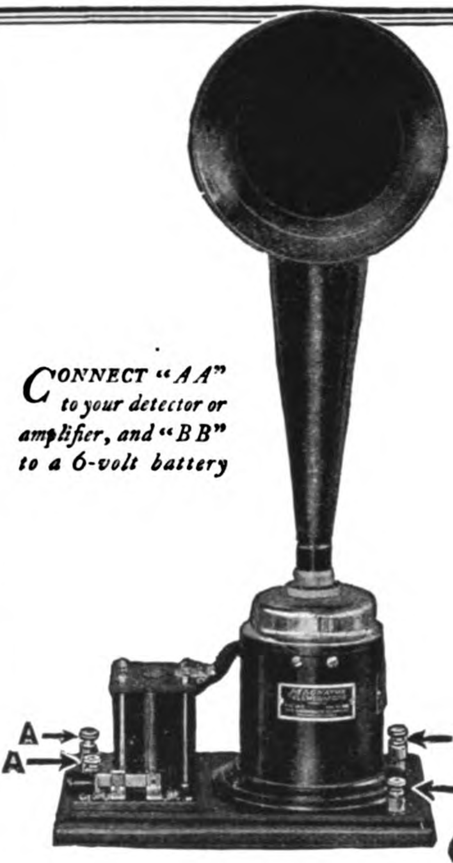

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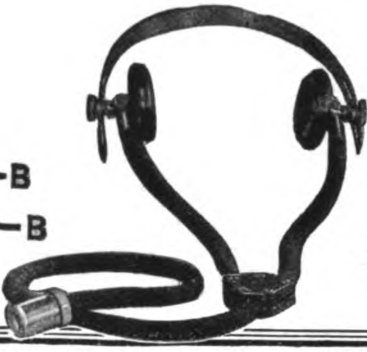

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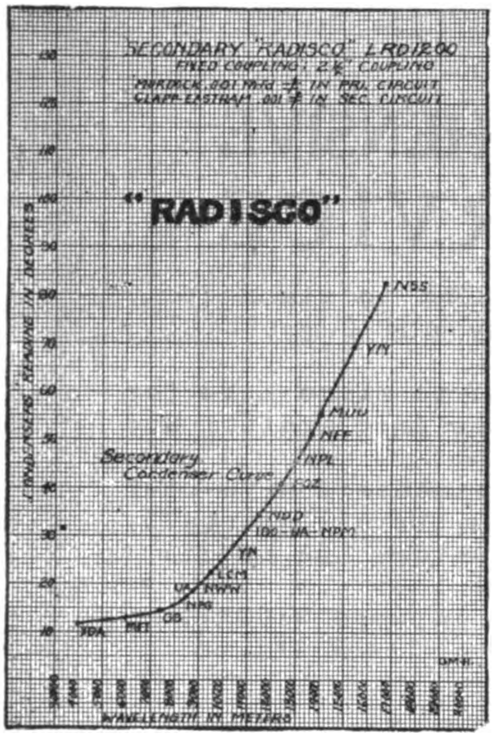

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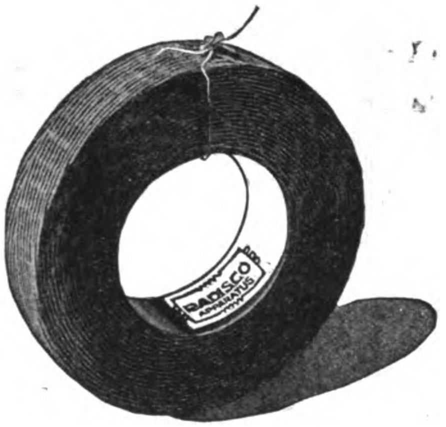

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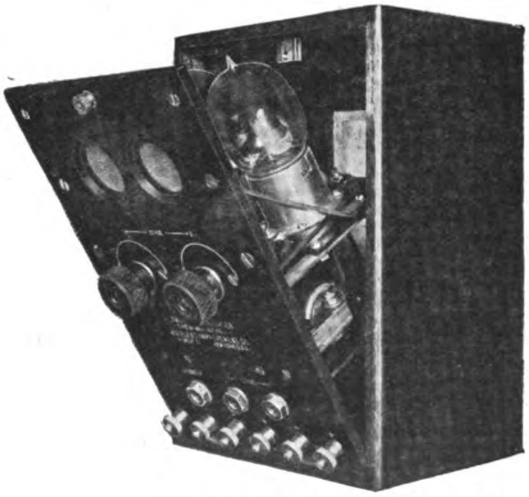

NOTE: The panel of our new instruments are hinged at the base. No marred panels or worn screws. Panel removed in 10 seconds.

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If this page is cut out and appended to the same page cut from the editions to follow, a complete file of very interesting information will soon be available. (No. 8)

Vol. 7. No. 12. SEPTEMBER, 1920

THE WIRELESS AGE

WORLD WIDE WIRELESS

International Yacht Races Reported by Radio

IN the international yacht races radio and seaplane and dirigible were used by the Evening Post and for the first time a detailed report was given by wireless from the air.

Beyond all doubt future yacht races and such events will be viewed from above, and wireless telephone and telegraph will transmit the story to the printed page. They will be watched from the air because from above the view is comprehensive and all-embracing; they will be reported by radio because all the air is a sending medium.

In the seventeen years since the last race for the cup wireless has become a perfect working machine and the seaplane carrying wireless equipment has been perfected. Today we are able to report the yacht races from a seaplane equipped with a radio outfit direct to land, to receive the signals loudly and with the utmost certainty and to send immediately acknowledgment of receipt by radio to the seaplane.

For the 1920 series of races a staff of three men—a reporter, a photographer and a wireless operator in a large seaplane, equipped with wireless, sent the story into the offices of the Evening Post. The machine was a large converted flying boat of the Curtiss H-16 type, with two Liberty motors and a 96-foot wing spread. It was equipped with a trailing aerial 500 feet long and a transmitting set with a sending radius of more than one hundred miles. Reports were sent direct to the offices of the Evening Post, where they were transcribed by operators and set into type.

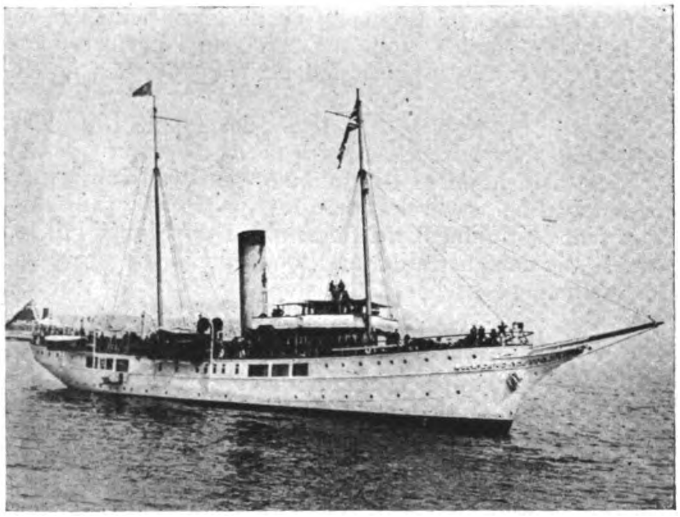
The receiving set was very sensitive, highly selective and capable of giving loud signals to facilitate copying without headsets.

The antenna used consisted of a number of parallel wires stretched above the roof of the building to a nearby building and running into the sporting editor's office. Appropriate ground connections and lightning protection switches were provided. The installation was carried out by the Radio Corporation of America. The actual receiving set and its adjuncts were specially assembled for these tests by the research department of the corporation. The receiver itself is a highly selective coupled instrument of the type used by the United States Navy. The received signal passed into a powerful multi-step amplifier using vacuum tubes for the amplification.

Those carrying on the tests were not content to use the ordinary methods of receiving wireless signals, which require the operator to wear clumsy telephone receivers strapped to his head. An additional amplifier of very special design was provided, which increased the volume of the signals in a loud speaking telephone receiver until it was very easy to read them all over a large room without wearing any telephone receiver whatever.

Some idea of the loudness of the signals can be gained from the following unusual results. Land and ship stations were easily read at a distance from the receiving set. The time signals regularly sent out from Arlington, Va., several hundred miles away, have been read three floors below the receiving set in the same building. While the signals from a distant ship station were thundering out, one of the attendants of the set remarked, "I'd rather listen to a hot battle in France than this racket."

The West Street, New York, station of the Radio Corporation of America was used for answering the airplane's messages on a special wavelength. This station is admirably suited for the purpose, being normally used in carrying messages to and from ships. The Radio Corporation made the necessary alterations and additions in the West Street station whereby the signals of that station would be readily received on the airplane but without interfering in the least with the usual harbor radio traffic.



Indicating the changed conditions in communication since the international yacht races seventeen years ago, this view of Sir Thomas Lipton's yacht Victoria, with wireless antenna strung from her masts, illustrates the modern marine practice of communicating by wireless

A loop telegraph wire was then connected between the receiving set in the Evening Post building and the West Street station, and the control key of the West Street station placed next to the receiving set. Thus the receiving operator in the newspaper building controlled the transmitter in the West Street station, although he was a considerable distance away. This novel departure neatly met the requirements and had the further advantage that it could be used for "duplex" working if desired.

The procedure in handling traffic was along the following lines: The seaplane sent its report of the yacht race to the Evening Post building. The receiving operator sent back his answer to the airplane from the West Street station, controlled over a telegraph line.

Results of Radiophone Experiments at Signal Hill Station

DISTINCT wireless telephone messages were exchanged July 24 between the Marconi Radio Station at Signal Hill, St. John's, N. F., and the steamer Victorian over a distance of 1,250 miles, according to announcement made by the manager of the station.

He said that the Victorian reported giving a wireless telephonic concert for passengers aboard the Olympic and other steamers and that thanks were returned by the same means from some of the ships.

The concert was repeated several hours later, with favorable results. The Victorian also was in constant telephonic intercourse with stations in England.

Highly successful conversations by wireless telephone took place July 25 between the station on Signal Hill, at St. John's, N. F., and the steamer Victorian, 600 miles distant and bound for Sydney with the Imperial Press Conference aboard. Keen interest was shown by the citizens of St. John's, who saw Marconi's original wireless telegraph experiments nineteen years ago, and the progress of the Victorian with daily bulletins of the telephonic concerts and other communications was eagerly followed.

The delegates were officially welcomed by wireless telephone to this side of the Atlantic when Premier Squires, in the name of Newfoundland, speaking into the transmitter, greeted Lord Burnham, Chairman of the delegation, on the Victorian.

The conversation lasted five minutes. Lord Burnham acknowledged the greetings and on behalf of his associates thanked the Premier for his welcome and complimented the Marconi Company on its great achievement.

The voice sounds from the ship came perfectly and every syllable was audible, said Mr. Squires, and he expressed the opinion that the experiments would mark an epoch in the history of wireless development by demonstrating that wireless telephony can become just as practical a medium of transatlantic and transcontinental communication as wireless telegraphy. During the afternoon many prominent men assembled on Signal Hill to witness the demonstration and took part in the conversation with those on board the ship.

When Chelmsford, England, was giving a wireless telephone demonstration to Denmark at 5 P. M. on August 2, the experimental station on Signal Hill, St. John's, N. F., picked up the sounds and heard, without interruption, the words uttered by H. J. Rounds, the manager at Chelmsford, who was talking with the operator in Denmark.

Mr. Rounds was heard to tell Denmark that Melchior would sing. Signal Hill kept in touch and heard distinctly four songs sung in Danish, as well as the conversation that followed between Denmark and Chelmsford. Chelmsford and St. John's are 2,673 miles apart.

◆

Radio Compass Directs Airplane to Ship

GUIDED entirely by radio compass signals, a naval seaplane F-5-L left Norfolk and flew 95 miles on a "bee line" to pick up the battleship Ohio at sea, with no knowledge at the time of taking the air of the vessel's location. The seaplane then navigated its return to Norfolk entirely by radio compass.

Navy Department officials to whom the flight was reported said it was the first time radio compass apparatus had been used to direct aircraft to a ship.

Marconi on Radio-Pictures

"VERY interesting and very important," Senator Marconi described the discovery of how to transmit pictures by wireless, made by Mr. Th. Andersen, a young Danish watchmaker.

"I have not followed the experiments, but I know it can be done," said Senator Marconi. "Pictures were sent over telegraph wires several years ago, and what can be done by wire can be done by wireless. It will be of great interest to watch the progress made. The two chief uses to which the discovery can be put are the quick transmission of photographs for newspaper and police purposes."

◆

Chicago Talks to Catalina Island, 3,000 Miles Away

WIRELESS telephone communication between Chicago and Catalina Island, thirty miles off the coast of California, was established, when William Wrigley, Jr., owner of the island, talked to his representatives in Chicago. Twenty-seven hundred miles of land lines and thirty miles of wireless were used.

The telephone was tested for the first time when conversations were held between people in Chicago and the island. Voices were as audible as those in ordinary long distance telephone calls, it was said.

"It was wonderful," said Mr. Wrigley, who talked thirty-five minutes. "The only thing to mar the conversation was Mr. Patrick asking me the score of the Cubs' ball game, and the Cubs lost."

◆

Radiophone Messages Between England and Denmark

AN ATTEMPT was made on July 31 to send wireless telephonic messages from Chelmsford, England, to Copenhagen. The conditions for the attempt were not absolutely favorable, the air being laden with electricity, but still the attempt was a success. The first message was a greeting from Queen Alexandra to the Scandinavian people. There followed other messages and finally the opera singer, Melchior, sang the Danish, Norwegian, Swedish and British national songs, in all of which not one word was lost.

◆

Japan Links Warships and Airplanes by Radiophone

THE Japanese navy has established a wireless telephone service between warships and airplanes on the wing. According to the naval authorities improved wireless telephone apparatus is now installed on board all the warships belonging to the first squadron and will be extended to all the other warships within the present year.

◆

Alaska Canning Industry Uses Radio

"THE PIONEER," largest floating cannery in the world, has left Washington for Alaska for the canning season. Besides carrying canning equipment, the barge has a complete wireless outfit, and quarters for crew and cannery workers.

◆

California Issues First Franchise for Radiophone Service

THE first franchise for wireless telephone service to be granted by any city was approved by the council of Avalon, Calif. The new system is to connect the island with all mainland long-distance exchanges.

French Lafayette Station Finished

ONE of the largest and most powerful wireless stations has just been completed near Bordeaux, France. It was begun by Americans according to American plans, and was half finished at the time of the armistice. Now it has passed into the hands of the French Government and will be used to send messages half way round the world.

The antennae are carried on eight metal towers 240 meters high and cover a space a kilometer and a half long and 400 meters across. Each tower, which is supported on three legs, weighs 550 tons, a quarter of the weight of the Eiffel Tower.

This Lafayette station, as it is called, uses an alternating current of 11,000 volts, with a frequency of fifty cycles, which can develop Hertzian waves up to 23,000 meters. The distance at which messages can be picked up is estimated at 20,000 kilometers—about half the circumference of the earth.

◆

Radio Corporation of America Completes Organization

THE Marconi Wireless Telegraph Company of America, which operated from 243 Washington St., Jersey City, with the New Jersey Corporation as agent, filed a certificate of dissolution in the office of the Secretary of State August 2, by which it ceased to do business in New Jersey.

Former United States Attorney-General John W. Griggs was president of the concern which has been absorbed by the Radio Corporation of America.

◆

Radio-Controlled Moving Target for U. S. Warships

THE once famous battleship Iowa, which played no small part in the destruction of Cevera's fleet at Santiago, is being prepared at the Philadelphia navy yard for a unique target experiment.

Proceeding unmanned but under her own steam and controlled by radio, probably from seaplanes, the old sea fighter will become the objective of the big guns of the Atlantic fleet superdreadnoughts in Chesapeake bay late this summer.

This will be the first time American warships have used a moving craft for a target except in actual war.

It is expected the practice will give the gunpointers of the Atlantic fleet an opportunity to test their ability under conditions as nearly like those to be expected in battle as can be obtained.

Smoke screens will be thrown around the Iowa during the runs and the course will be changed at will through the radio control system, necessitating a change in range on all the firing ships, exactly as would occur in action.

◆

Graded System Likely to Settle Radio Operators' Difficulties

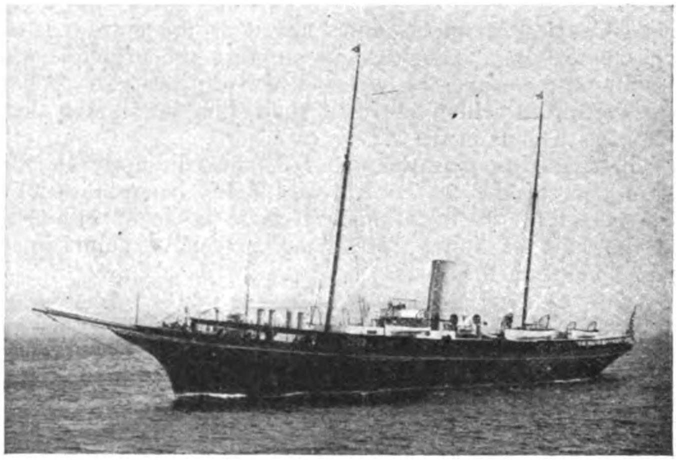
THREE independent plans for a system of graded licenses for radio operators are being worked out, it is understood. The leaders of the wireless operators, in accepting the proposal made by Admiral William S. Benson, chairman of the Shipping Board, for the extension of the life of the present agreement ninety days, have communicated with the various locals of the association. In the meantime they are endeavoring to work out a system whereby years of experience will be rewarded with better pay and the amount of work done will have some relation to the wage received.

The Shipping Board has referred the matter to Eugene Chamberlain, Commissioner of Navigation. The American Steamship Owners' Association was not consulted by the Shipping Board prior to the suggestion of an extension of ninety days in the life of the agreement. It is known that the shipowners are opposed to the granting of increases in wages to the operators, although they are not unsympathetic to the desire of the wireless men to better their condition.

The radio operators are working out a plan, which will be submitted to Commissioner Chamberlain for due consideration.

It is reported that the three wireless companies, which are under contract to the shipowners and the Shipping Board for furnishing sets and operators, are laboring on a plan which they think will solve the problem now facing the shipping interests.

The Shipping Board, in conjunction with the Commissioner of Navigation, is understood to be active in regard to the scheme. It is said that the governmental board feels that the radio service should be encouraged and that there ought to be some stimulus for an operator to remain in the service after he obtains the position of a chief operator. At the present time he could not make more than $125 a month if he confined himself to radio work.



The modern equipment of yachts like J. P. Morgan's Corsair, illustrated above, includes a complete wireless outfit

The shipowners do not feel disposed to grant the demands made by the operators recently. The wireless men wanted an eight-hour day, with provision for overtime pay, increases of $75 monthly for chief operators and $50 for assistants, assurance that the operators would not be required to perform additional services on board ships and that they would be permitted to leave the vessels when they were in port. By figuring overtime on a rather liberal scale the shipowners figured that a chief operator, who did not have to be more than twenty-one years old, might draw as much salary as a first mate on a large freighter. They were not consulted by the Shipping Board, but it is understood that they have been asked to write to Washington and inform the Commissioner of Navigation what their views of the situation are.

While it is felt that a strike among the radio men has been largely dissipated by the conference with Admiral Benson, the possibility has not been entirely removed.

At the present time there are only two classes of operators, chief and assistant. It is thought that the salaries of the operators should be increased with the performance of certain years of service. For instance, it is believed that the Commissioner of Navigation will recommend a certain percentage of increase every few years.

No statement has been made by the president of the United Radio Operators' Association since he returned from Washington, where the conference was held. It is thought that it will be several days before the system will be worked out to such a point that there can be an intelligent discussion of its merits and defects.

Wireless Signal Lamp

A WIRELESS signal lamp has been devised for various kinds of war work which enables the users to keep up communication under conditions where it would be difficult or imposisble to stretch telephone or telegraph wires. A barrage fire, for example, would be no hindrance to signaling by this new apparatus. It can be used between a ground station at the battle front and an airplane a considerable distance away, flying over enemy territory.

◆

Maine Fisheries Company Uses Radio

A RADIO station has been established at Rockland Highlands, Maine, by the East Coast Fisheries Company. Primarily it was erected so that the company might communicate with its steam trawlers.

◆

Wired-Wireless System Installed at Chesapeake Capes

ARRANGEMENTS are being made by the signal corps at the request of the chief of coast artillery, to install the new "wired-wireless" system of radio communication between the fortifications at Cape Henry and Cape Charles, about 28 miles apart, at the entrance to Chesapeake Bay. The system employs the principle of guiding radio waves by wires, which do not have to be insulated, and which perform their function under the water, as well as in the air.

The installation at the capes of the Chesapeake will form part of the fire-control and other communication systems at the fortifications. It is to be made because of the lack of funds for laying expensive submarine cables between the forts.

◆

Marconi Radio Service Between Argentina and England

THE Government of Buenos Ayres made public, July 31, a decree allowing the Marconi Company to install and operate a wirelss high-power station to be used exclusively for communication between Argentina and Great Britain.

◆

Wireless Wanderings

FLAT on his back an indolent philosopher held forth on the joys of "wireless travel," as he called it.

> "We have been reading about the yacht races reported by wireless telephone. Then comes a successful experiment with transmission of pictures by wireless. Next we will have the wireless movie.
>
> "When that time comes I shall be able to enjoy my penchant for foreign travel without the suffering of seasickness.
>
> "I'll hire a movie aeroplane equipped with a wireless motion picture transmitter and start the flyer on his way. I'll lie here on my back and watch the panorama of the earth unfold on a screen mounted on the ceiling.
>
> "When the aeroplane passes over a place that looks interesting I'll signal for the aviator to descend and get close-ups with the wireless movie machine, and start the wireless telephone to working so that I can hear what is going on."

Whether philosophers are optimistic depends on the philosophers. The indolent variety usually are. But even granting the optimism, the forecast is not so impossible as it may sound.

Grandparents of the present generation who might have dared to indulge in speculations on flying, wireless telephony and wireless telephotography would have been considered insane.—N. Y. Evening World.

Radio Message Explains Mysterious Blast off Jersey Coast

THE mystery of the explosion twelve miles off Avalon, N. J., July 28, was solved when Captain George Painter, of the motor schooner Mackintosh made explanation after arriving at Atlantic City from Beaufort, S. C., with a load of fish. They found that the 1,000 tons of oil discharged from the Cabrille, grounded on the Brigantine Shoals, was ruining the fishing. The engineer ignited a bundle of waste and threw it into the sea. The whole sea "caught fire" and as the flames streaked from oil pool to oil pool there were loud explosions and the Mackintosh had to escape as fast as possible.

When it became impossible to locate the tanker Kehuku it was believed that she had blown up. But this report was dissipated when a wireless announced that she had passed the Jupiter lightship off the coast of Florida.

◆

Moonshiners Using Wireless

THE fight against the illicit still in southern West Virginia will never result in victory for state and Federal prohibition officers because of insurmountable difficulties encountered.

The layman does not realize the difficulties of enforcement officers, according to one revenue agent operating in the Charleston district. In one instance the resourcefulness of the moonshiner has surrounded his business with the protection of a wireless system. A complete wireless telegraph outfit has been installed in the mountains near the West Virginia, Kentucky and Virginia lines, through which distilling plants are notified by a code of signals from confederates when danger threatens.

Apparently meaningless wireless messages have been picked up in Charleston by William H. Moore, a wireless student, believed to have been sent by moonshiners "in distress."

The new method of protection not only has worried but has seriously handicapped raiding officers, who swoop down on a spot where a still was reported to be in operation, only to find the outfit missing.

It is said that several of these radio stations are located convenient to railroad towns and are used by confederates of moonshiners when a suspicious stranger or an officer known to the clan is seen in the town or about to leave on a mountain raid. One of these outfits is reported in the Pound section of eastern Virginia, where moonshine formerly flowed freely, but following a general raid Corburn and nearby towns are reported dry as the proverbial bone.

So far as known these are the first moonshiners in the country to adopt a wireless system in connection with their business.

◆

Pictures Transmitted by Radio

A DANE, Th. Andersen, has made an important invention by means of which pictures and sketches can be transmitted by wireless over long distances, for instance from Europe to America.

The invention has been tested by experts who pronounced it to be of great practical value, especially for press illustrations. The apparatus is of the most simple construction and easy to work. Any wireless telegraph or telephone system can be used for transmission and the cost of working is said to be very low.

One Copenhagen newspaper has published two photographs sent by means of the new invention, one of them being a portrait of Chancellor Bauer despatched from Berlin.

The New Radio Station at Lyons

Disposition and Housing of the Installations

By Lieut. Leon Faljau

EDITORIAL

LIEUT. FALJAU'S account of the Lyons radio station in this issue invites comment regarding several points.

The arcs in use at Lyons are, in many ways, of interest to Americans. For their power they are as great an improvement over previous types of the same output as the Curtiss turbine was over the reciprocating types of engine. The French have installed the Elwell design of the Poulsen arc while the U. S. Navy so far has favored the Federal company's type. Altho the latter has an iron weight efficiency vs. power output only about 10 per cent. that of the former, a greater conversion efficiency over a wider range is claimed for it. Elwell engineers collaborated in the installation of these arcs after designing them. Whatever may prove to be their "survival value" the Lyons station is a tribute to American engineering initiative in this respect.

The generous spaces allowed for future additions are very noticeable in this station and are in line with the American tendency, as the multiplex idea is approached in large stations, to regard the station proper as a central generating station, controlled by substations.

The French have gone to some trouble to keep the mechanical and electrical features of the antenna up-to-date. Their method of securing better current distribution in the antenna and the concomitant increase in mechanical stability is worthy of study.

The double system of speed control of the 20,000 cycle generator set is ingenious. It naturally invites comparison with the Alexanderson system, which regulates even more closely.

The "blanks" of sending are those intervals during which the "choking" resistance of the antenna is in circuit. This has the advantage in some cases over the compensating wave, that the change in full sending current is more rapid—the presence of resistance assisting the changes through decreased time-constant. The compensating-wave system may require more time to achieve the required resonant rise on the sending interval, and a 200-word a minute sender may not afford the time needed. One may "chop" a wave mechanically as rapidly as desired, at some cost of broadened tuning, but one may not control its growth except by purely electrical means. It is a question for careful judgment, as to which of the two systems can be evolved so as to finally outstrip the other in sending speed. American practice of 50 to 200 words a minute for commercial service augurs well for immediate expansion of projected commercial systems of world chain stations, to challenge the ubiquitous cable.

Those who laid the ground work of radio engineering before it came to be listed in academic curricula will note the confidence with which attention is drawn in Lieut. Faljau's inventory of special features, to the original design of the antenna loading-coil. It is a hyperboloid of revolution, having the radius of top and bottom turns equal to its height. Surely the designer must have heard of the constant flux coil known a generation ago and clearly indicated in Gray's "Measurements in Electricity and Magnetism," not to mention numerous similar works.

Gray, applying Maxwell's equations, shows that a new diameter required for an additional turn to n turns on a coil, must follow such a law that the resultant field will continue to "follow" the coil profile. This means an increasing diameter. Years ago the General Electric Co. used an hyperboloid choking inductance in its lightning arrestors.

The general fact that the flux area increases as it leaves the coil, and even swings around at a critical distance from the coil-face, was shown by Gray and others to allow a maximum coupling, with a given flux in the primary, of a secondary of critical diameter, at the critical distance. The Campbell mutual inductance standard is based on this principle. Two primaries are placed at the critical distance on opposite sides of a secondary of the critical diameter. The condition of a maximum coupling causes the accidental errors due to unknown displacement of the secondary coil to be practically zero. Whatever residuals are present cancel out.

American firms long ago saw the advantages as regards improved time constant and coupling qualities in the hyperboloid, but they cut it in two on account of mechanical considerations. As the tapered or conical coil it has been tried out as early as 1906, but the production engineer will have none of it.

The Lyons station is a tribute to French thoroughness and sense of refinement and to American initiative in showing the world that the high frequency alternator was practical before the quenched spark was applied to radio.

THE Lyons radio-station situated at Villeurbanne, France, n.e. section of the larger city, back of the Rhone dikes, now affords the appearance of a large transformer substation.

As a matter of fact the energy supplied to it by the Jonage lines, as 50-cycle three phase current, is transformed there into high frequency energy and distributed throughout the world to different correspondents by means of one or another of the four arrangements now in operation, viz:—

A spark station of 150 kw. Arcs of 200 kw. Arcs of 450 kw.

The new 150 kw. Bethenod alternator of 20,000 cycles.

The station, properly speaking, comprises the machinery hall where are assembled all the transmitter installations, an adjacent office building, where among various divisions is found the receiving and telegraphing room and an annex, situated at the north of the main hall, containing the 200 kw. arcs.

The machinery hall shows in plan, the aspect of a

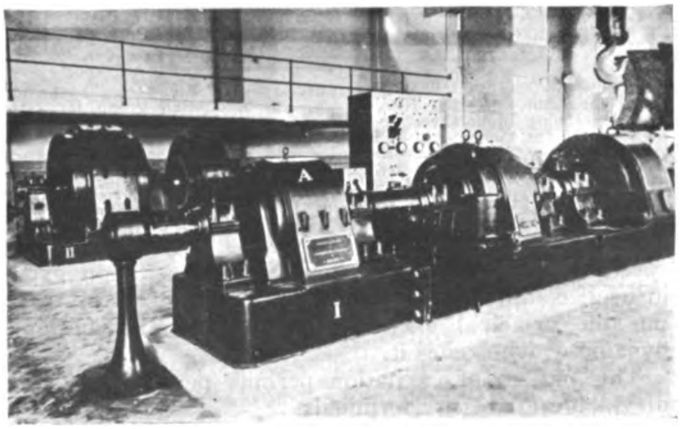


Figure 2—The two sets for the spark station

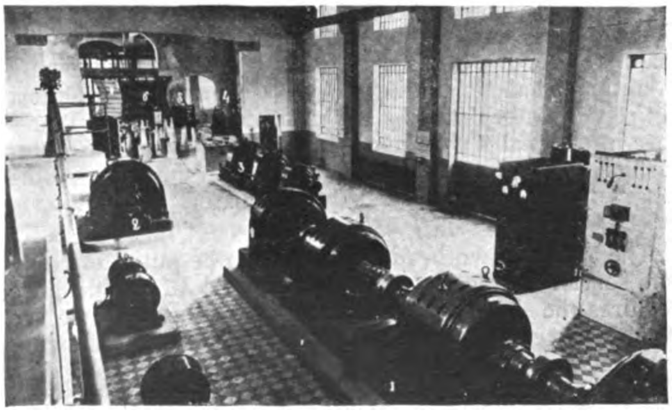


Figure 5—The Bethenod Set, marked as No. 3, in background; at the rear-right (No. 4), are the four Tesla coils

vast "T" and the small sketch herewith attached shows the arrangement of the apparatus in this hall.

The rear of the hall is partitioned off, forming in this way a large section containing the apparatus constituting the damped wave set. On this side are found the Jonage supply—at 3000 volts—to the transformer group, the two groups of 450 hp. feeding the damped wave set; their excitation auxiliaries and on a platform, the switchboards. At the middle is placed the high frequency group, the dc. set which furnishes it with the necessary driving current and its own switchboards. The large antenna, loading-coil of which we will again speak, occupies an emplacement which is at this end, under the cupola.

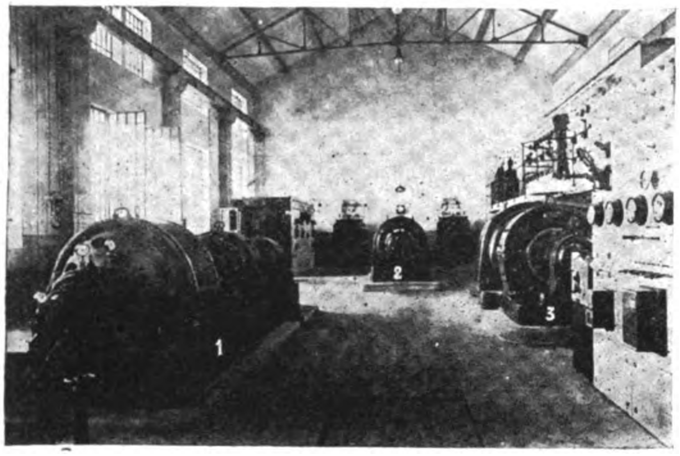


Figure 4—At the back, the spark sets and the transformers. In the foreground, the Bethenod Set. To the right, the 3-phase motor-generator set driving the H.F. set

We thus come in our progress, to the transverse part of the "T" where are on one side, two arcs of 450 kw., the group of 680 hp. which supplies them and various switchboards; on the other side—an emplacement still vacant which will certainly come to be occupied by new apparatus—a new alternator according to all probability.

All the accessory apparatus, pumps, compressors, rheostats, contact-makers, etc., are mounted in the basement, being controlled, for the most part, by switchboards in the hall.

The operating room is conveniently arranged in the neighboring building. Two large tables there, hold the manual or automatic sending apparatus, the tape-punching machines and the receiving systems. A desk-switchboard carries the cut-outs and the switches for the 110 volt dc. supply which works the various relays (key and turbine types) and the contactors. Finally, an indicating signal transmitter, of "marine type" connects the hall of machines, to take care of orders to start, stop, etc.

The installation thus shows in its entirety the qualities of fitness, order and thoroughness of a modern electric station, and also allows for new and necessary arrangements which will be necessary in order that the station may measure up to the progress made in the radio art.

The spark-set has been out of commission for some time already, and without doubt it will be shortly dismantled. As for the 200 kw. arcs erected rather hastily in an independent building, they are from now on almost entirely to be replaced by those of 450 kw. I will therefore intentionally pass over the description of these old-fashioned installations, in order to devote myself at some length to the new arcs and the alternator.

The 450 kw. Arcs

The arcs are two in number and can be put alternately into service during the time that the work of maintenance requires the shut-down of either one of them. They are of the Elwell type and are made up in the following manner:

At the center of a double walled bronze chamber, which a current of water cools, are situated the pole pieces of an electromagnet. It is in the air-gap of these pole pieces, whose diameter is greater than 32 cm. that the arc starts between an anode of copper and a cathode formed of a carbon cylinder, 6 cm. in diameter, mounted in a revolving tube. The current which starts the arc, supplies the electromagnet, and the action of the switches allows any desired field to be obtained, by putting more or less of the field-winding turns into action. The cathode is grounded, the anode, insulated from the arc chamber by a quartz cylinder, is connected to the antenna loading inductance and the whole is shunted by a battery of condensers.

At the side of each arc is found a desk-switchboard, for the controls for the contactors of the field-switch and the water and gas cocks. That for the contactors, "shorting" the series resistance, is placed in the circuit first to provide "choking" and then to let the set function. The same 110-volt dc. current serves to work these controls and it may be broken at different places in the station when safety requires the complete cessation of transmission. No false manipulation need be feared.

The sending is effected by short circuiting an inductance of small size interposed in the antenna, and thereby producing variations of the transmission wavelengths. The longer wave is the signal wave. It is the working wave, and the shorter wave—the compensation wave—corresponds to the sending intervals.

The sending-key, which has to make or break the "short" of that inductance, is a powerful and delicate relay. It comprises a primary electric relay, worked by the sending-key in the receiving-room, this relay then acts on a double pneumatic system of small inertia, working an arm carrying contactors. The arc produced at the break between the silver contacts is extinguished by an intense air current. These keys permit a sending speed of 2500 words per hour. The excitation group in itself comprises an independent motor of 14 hp. driving the principal exciting dynamo and the auxiliary dynamo which excites it.

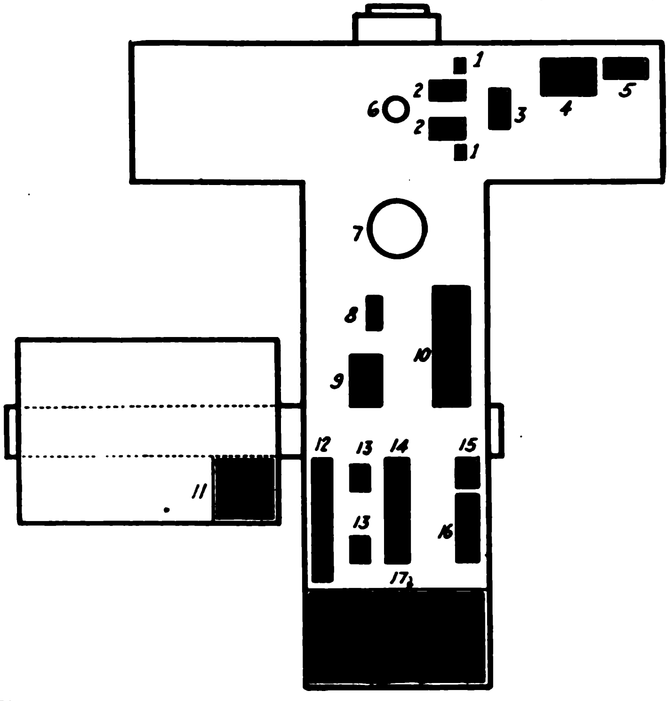


Figure 1—1—Desk switchboards for arc. 2—450 Kw. arcs. 3—Switchboard for same. 4—680 H.P. group. 5—Excitation group for same. 6—Telegraphing inductance. 7—Large antenna loading-inductance. 8—Switchboard for starting up H.F. group. 9—Group of convertors. 10—High frequency group. 11—Reception and sending room. 12—Switchboards for the damped wave set. 13—Exciter for these groups. 14, 15—Switchboard for starting up the Convertor Group 9. 16—Transformers. 17—High tension room for the damped wave set

This system of excitation permits perfect regulation of voltage at the arc terminals.

A desk-switchboard placed near the arcs carries all the measuring apparatus pertaining thereto, and the controls of the starters and of the field rheostats which are located in the basement. The arc current is furnished by a dynamo of 6 poles—separately excited—capable of giving 450 amperes at 1000 volts. An asynchronous motor of 680 hp. is employed to drive it.

The Bethenod Alternator

For some time the radio post has had the high frequency alternator constructed under the supervision of the S.F.R. and the Alsacian Society, as the result of very satisfactory trials, and it is now in regular service.

The high frequency group proper, comprises a continuous current driving motor of 450 hp. coupled to two single-phase alternators, of 1000 and 20,000 cycles respectively. The first of these two machines is intended to function during the telegraphic blanks in transmission in order to keep constant the work of the group and consequently its speed; as a matter of fact, experience has shown that it acts sufficiently like a fly wheel through the mass of its rotor, and so its windings are not connected in. It may be used, in addition, to supply a musical spark-set in case the 20,000-cycle machine migh be broken down.

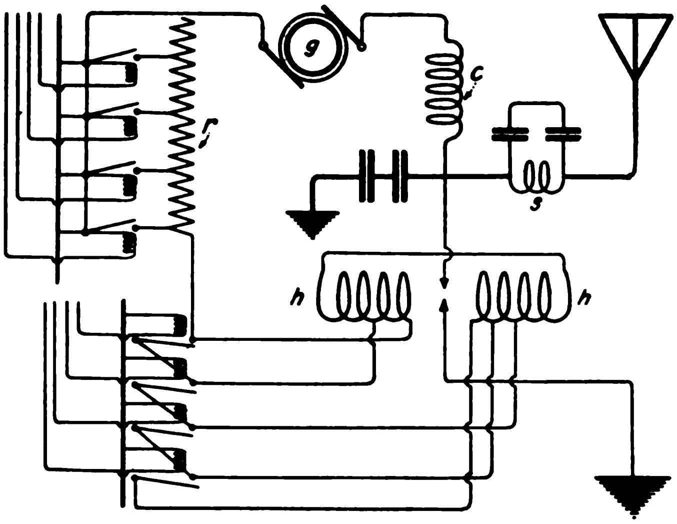


Figure 3—Scheme of arc connections

This 20,000-cycle machine is a homopolar alternator with revolving inductor. The rotor is unwound, is about 1 meter in diameter and revolves at a speed of 3000 r.p.m. Excitation is furnished by a winding, normal to the axis carrying 110-volt dc. The magnetic circuit is formed through the body, the rotor and the stator. The stator carries four pairs of coils, parallel mounted, each connected into the primary of a Tesla coil; the four secondaries in series-parallel are connected into the antenna. The method of sending consists in short-circuiting every one of the four stator windings, the short-circuiting current then being about 60 amperes in each of these sections.

The great difficulties encountered in construction are caused by the necessity of maintaining the speed of the group perfectly stable, from the balancing of the machine at 3000 r.p.m., and from heat-rises which hysterisis and eddy current losses produce, and which are difficult to eliminate.

The alternator-poles have been made with their cores very finely laminated—.01 mm. The pole faces being very much reduced—4 mm—the air-gap had to be reduced in proportion. At normal speed it does not exceed 3 mm.

A pump maintains the circulation of cooling-oil through the rotor, by a hollow shaft and around the stator. Another four-cylinder pump keeps up a vacuum in the body of the machine between the stator and the rotor. Finally a system of grease lubrication under pressure supplies the bearings.

Regularity of performance is assured by two systems. One regulator, mechanically driven by the group, acts on the excitation of the driving motor, and on the other hand, the voltage at the mains of the dynamo, supplying this motor, is itself maintained constant by a second regulator, of the Thury type, acting on its excitation. This last supply dynamo with 6 poles, and separately excited, capable of giving 750 amperes at 500 volts, is driven by an asynchronous 750 hp. motor depending on the 3000-volt, 55-cycle current of the supply net-work of Jonage.

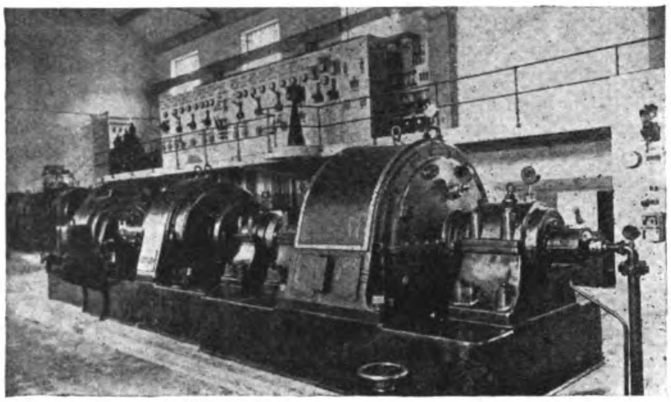


Figure 6—The Bethenod Set. From left to right, alternator giving 1000 cycles, driving motor, 20000 cycle alternator

In spite of the complexity of its mechanical elements, the group is very easily handled. It has—above all high power systems used to date—the advantage of giving a perfectly pure sustained wave. Checks by the Dufour oscillograph—recently effected—proved the form of the voltage sinusoid to be very regular. Though the machine requires careful watching it gives a steadiness of performance unknown to the arc, which requires frequent stops to change carbon, fix up the arc-chamber, etc.

The Antenna

The antenna is a formidable rectangular sheet raised to a height of 180 meters above Grand-Camp. It is supported by two rows of four masts, arranged to follow the long sides of a rectangle, having nearly 1 kilometer length and 240 meters breadth, oriented practically east to west. The two masts placed at the end of the sheet and at the entrance to the station are 200 meters high, the ten others are brought up to 180 meters.

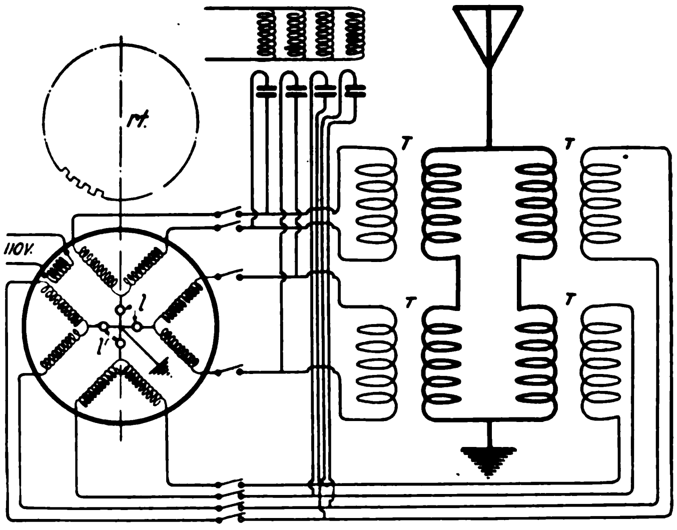


Figure 7—Scheme of alternator (20000) arrangement. rt—toothed rotor. l—lamps for grounding the mid-point of the stator windings. T—Tesla coils

The antenna surface is formed of twenty cables suspended parallel to one another. The respective distances between these cables increases from the ends automatically toward the station, which gives the double advantage of permitting an equal current distribution over the length thereof and of buoying up the centre of the sheet, thus diminishing the stresses in the supporting cables. On the east side all the cables fall directly toward the stations and are joined in a "crow's foot" to the cupola, which tops the hall over the large inductance.

The high powers put into action require considerably high insulation of the sheet and of all the metallic parts which hold it. The sheet is insulated from the masts by long chains of insulators. The masts themselves are insulated from the soil and rest on marble slabs and the guys which support them are sectionalized in various places by porcelain egg insulators.

In spite of these precautions continual maintenance of insulators is found to be necessary and the problem of insulation is complicated every day by the use of continually growing powers. When the 200 kw. arcs function one can still measure 100 volts between the soil and the last section of the guys below.

The antenna loading coil, studied and constructed through the efforts of the station officers, has the original form of a large hyperboloid of two meters in height. The largest section, that of the bases, is four meters in diameter. There are 28 turns of a copper band formed of thin laminations, insulated from each other, to reduce their high frequency resistance. Thanks to the carefully calculated action of this inductance the flux across any section is constant. Its rise in temperature is found to be much diminished and its efficiency considerably increased.

Such is, in a few words, the large station which connects continuously, France and America, and whose "press" is received even in the extreme Orient.

Before closing this brief description, I have to thank General Ferrie, to whom we are indebted for permission to publish these lines and for the series of photographs of his station and I ask my readers to join with me in giving homage to the commanding officer who has been capable of endowing our country with the model station which every day attracts the flattering curiosity of foreign delegations.—O. C. R.

Should all (Radio) Men be Created Equal?

By Edward T. Jones

EDITOR'S NOTE: In this article a wireless man with the broadest experience discusses a vital problem of present day commercial operating. In no sense is it propaganda for any interests, nor is it inspired by individual or associated employers. The manuscript came through the mail in the regular way and was submitted voluntarily by the author, who wishes to advance the art and asks that what he says be taken in all sincerity as the uninfluenced viewpoint of one who has made radio operating a vocation and rises to protest at the unsound conditions which have recently developed. It is published in the belief that these discussions will result "for the good of the service" and the Editor extends a wide open invitation to all interested to submit their views for publication.

Transatlantic operating room of Radio Corporation of America, where expert commercial operators are employed

RADIO OPERATORS! Radio Operators!—the constant cry of the shipping concerns.

The situation reminds one of the day the United States began to mobilize men for the great test against Germanism. Never before have we experienced such a boom in radio circles!

Three commercial radio concerns have opened service stations at fourteen points; namely, Boston, New York, Philadelphia, Baltimore, Norfolk, Savannah, New Orleans, Galveston, Seattle, Portland, San Francisco, San Pedro, Honolulu, and Cleveland to care for Shipping Board vessels under their supervision and in accordance with contracts entered into with the U. S. Shipping Board.

Competent men were needed to man these important posts and the list of old timers was practically exhausted. Then came a further drain upon the few pioneers, for the Shipping Board called for Radio Supervisors at each of the points mentioned.

Yet we hear a lot these days about wireless operating and the lack of good future.

The future depends entirely upon the individual. We who have worked our way up can look back and realize the path we have traveled. It is a straight and narrow path, and not an easy one, for its ascent meant the use of much midnight kerosene and the acquisition of tough palms. Too few endeavored to follow.

Sliding Wage Scale Best

The average pay today of a Wireless Operator is $125 per month, against the pre-war scale of $40, $50, and $75.

The pay is attractive, but the question arises whether efficiency and improvement of the service as a whole will result from planting a man aboard a ship at $125 per month and holding him stationary.

Experience Counts for Naught These Days

According to the present wage scale when a young man emerges from a radio school with a license—and few are so feeble-minded that they can't pass the present Wireless Examination—the sweet graduate proudly walks over to a commercial radio company and hangs up his hat with those who have been actively engaged in wireless telegraphy five or more years.

It's all wrong. Some form of sliding scale should be adopted. I do not care to attempt fixing a maximum wage per month, but I do believe that a man without any experience in commercial wireless telegraphy should not receive more than $75 per month to begin. Let him then show his mettle, experience the hard knocks familiar to all old timers, and gradually attain the stature of a *man* and—after a certain length of faithful service—automatically have his salary raised.

There should be:

Something to look forward to.

Something to be proud of.

Something by which the shipping concern can have guaranteed Service, with a capital S.

Understand, I am not placing a limit to the salary a top-notcher should receive; I believe he should be paid in comparison to other officers of the vessel with whom he ranks. But it is worthy of emphasis that in the daily performance of their duty the other officers of the vessel constantly furnish guarantees of their ability and faithfulness, whereas the operator's primary duty is in connection with the safety of life at sea—and his test of sincerity, faithfulness, and ability, only comes at a critical moment. It is when the vessel is in distress that the wireless operator is of *prime importance.* What guarantee has the ship owner that he will perform his duties faithfully?—without experience.

Lengthy experience equips a man to handle most any situation; for that reason alone he should be paid a higher salary. There is no other vocation that classes the beginner and the expert alike, paying the same figure of compensation from assignment until death.

Second Grade Tickets

Consider the man with a second grade ticket. Does he deserve the same salary as a man holding a first grade ticket? On a one-man ship it matters not, according to the present ruling. On any ship a second grade man is not worth more than $50 per month to begin. Actually he is serving an apprenticeship with pay. In many other trades, board and lodging would be the sole return.

Operators Bettering Themselves

Maybe this is the reason why out of every ten men you will find about two who keep up with the radio game, through magazines, books, or otherwise. In fact, lately, due to the ever increasing demand, wireles operators appear as a class of world tourists only, for it is generally known that most operators make one trip per vessel. Why should they worry? All ships pay $125, and it matters not where one goes; it is easy anywhere to secure a billet.

Not until some arrangement is arrived at whereby justice shall be meted out to all, and wireles operators strive for the betterment of the art by devoting their spare time to personal improvement through study, shall we receive the recognition our skill merits.

Let me give an example of present day conditions:

An operator from a certain vessel came in one day and reported his "machine" sparking. I immediately asked whether it was the motor or the generator. After a little pause he said that it was at the *left end!*

In no uncertain tone I inquired how was I to know what was on the left end of the "machine" on his particular ship!

That is but one among numerous instances. Many men, like this one, take a student's course or learn the questions and answers to the Wireless Examination, and know there is a motor and a generator in the "machine," but fail to observe which is which.

When you mention vessel assignment to this type of youngster, he invariably wants to know first of all, where she runs, how long is the trip, if the grub is good, if there are shower baths. When you finally convince him that the vessel is OK, likely as not he says in effect: "All right bring it in. Let's take a look at it." The average may not be half this bad, but we actually have one man in this district who insists that he will not sail without a private bath.

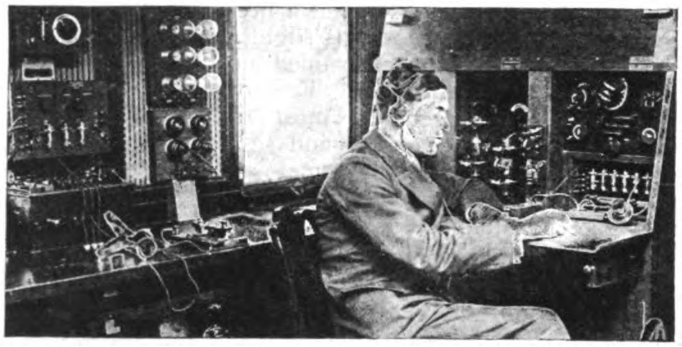
Our concern, however, is with those who are worthy of the traditions of the sea. Which brings us back to the subject of salary, with a view toward establishing a maximum salary for old timers and men of ability in conformity to the pay of ship's officers with the same rank.

For beginners I advocate the following wage scale:

Second-class license	$50.00 per month
First-class license, first six months..	75.00 per month
First-class license, second six months.	100.00 per month
First-class license, end of 18 months.	110.00 per month
First-class license, end of 24 months.	125.00 per month

And so on, according to the salary arrived at as the maximum, with allowance for 15% increases for an extra grade license governed by the periods of actual service as provided in the table.

I expect yells of "Murder!" from those at whom this paper is directed; which matters not, since my object is placing radio telegraphing on a higher plane, and there are many in the game who are fair-minded.



A corner of the operating room of the Radio Corporation of America showing some of the control instruments

When men start in at a small wage and something is placed in front of them as a goal, better service is a certainty. Higher efficiency requires general betterment and the men will actualy strive to do well so that when their time is up another addition of winged demons will find their way into the pay envelope. The employing company will also be given a fair chance to study and judge the men in their employ and weed out the unfit. The man with the ability will gradually rise and it's a certainty that the Company will not fire him because he has arrived at a large salary. Why? Because men like him are scarce as hen's teeth. If you don't believe it, inventory yourself and see whether or not you are fit to man a good healthy shore station job with its several Morse lines and radio schedules, not overlooking the other qualities necessary for such a position. Less than one out of every 100 men aboard ship today are capable of actually manning a good live hot shore station roast. Still they wind-jam about what they can do and what they have done.

In the next few years radio is going to be changed entirely; probably to undamped apparatus. How many self-styled operators will be ready to speak with understanding about the new gear? How many will keep tab on all the radio periodicals, study, and strive to perform their duties as a man in the radio profession should? Those who will have done these things will be the ones ready and willing to give to those who have been in the game before them and who are possessed with ability, the right to a better salary.

There is a need right now of a common sense agreement. What have you to say, old timers?

Universal Honeycomb and Lattice Coils

The details of checking the classification of the formulae for lattice windings are so numerous that the third instalment of this series could not be completed for the September issue. It will appear in October.

Radio Operator's Story of the Comus-Lake Frampton Shipwreck

WITH a calm sea and a cloudless sky affording ideal conditions of navigation, the Southern Pacific steel passenger steamship Comus crashed into the steel United States Shipping Board freighter Lake Frampton at 3.15 A. M. July 12th about eight miles off Atlantic City, New Jersey.

The freighter sank in ten minutes, carrying to death an oiler and a fireman. The Comus's bow was slightly damaged but the liner sustained no other marks of the impact. Few of her sixty-four passengers, most of them women, were panicky and several aided in rescuing the remaining thirty-two officers and men on board the Lake Frampton.

The story of the shipwreck is here described by H. L. McCeney, the Radio Operator of the Lake Frampton:

I was asleep in my bunk on the morning of July 12th when a crash which occurred at 3:15 A. M. threw me out. Running to the deck I heard the alarm bells giving their signals. I tried to reach the captain to get orders as to the transmission of any possible message, but the only orders the captain issued were: "Abandon ship immediately." We were going down rapidly.

The Lake Frampton listed to port so much that it was impossible to launch the life boat on the starboard side. However, the life boat on the port side was rigged up and about fourteen of the crew got into it and the lines were cut to allow it to float away. There was no chance for me to reach the life boat so I climbed to the starboard side of the ship which was high in the air at the time, and when I thought the ship was settling, slid down the side into the water. It was quite dark and visibility was poor. After being in the water a while I swam toward the life boat, but it kept drifting away because the crew aboard had no oar-locks with which to control the direction of the boat. As it was impossible to reach it I swam toward the Comus, which lay off about one mile distant.

H. L. McCeney, radio operator aboard S.S. Lake Frampton, as he appeared on landing after the sinking of his ship

Reaching the Comus almost exhausted, I was hauled aboard in between decks through one of the square portholes, and from there carried to the baker's sleeping room, where warm drinks and dry clothing were given me. After being aboard an hour, the first operator of the Comus, Louis J. Gallo, took me to the wireless room. I had been reported missing, though I was one of the first to be rescued, but being on the lower deck, no report had been made on my rescue.

The collision and sinking of the Lake Frampton happened so suddenly that there was no opportunity to use the wireless apparatus in securing aid. From the time of the collision to the settling of the boat, about 15 minutes elapsed. The second operator on the Comus, E. L. Chesbro, was on watch at the time when the crash came. Gallo immediately came on deck, without being properly clothed, and sent Chesbro to get orders from the captain while he took the watch in the radio room.

The captain placed Chesbro on the bridge to operate the flash light and other signals to aid in rescuing the men from the sea, and consequently he did not return to the wireless room for over a half hour, so Gallo sent a message to the steamship company reporting the collision and stating that the Comus would stand by until daylight to aid in the rescue of the Lake Frampton's crew. Other stations stopped when Gallo interrupted with "QRX" and Captain Powers of the Lake Frampton later sent: "Lake Frampton rammed and sunk at 2:20 A.M. Oiler and fireman missing." Several ships and some naval stations who were calling for particulars were also worked. After all rescue work had been attended to and a thorough search had been made for the two missing men, the Comus steered for New York.

The first operator aboard the Comus, who was aboard the Sister Ship Proteus when she was sunk in 1918 by the Tanker Cushing, south of Diamond Shoals off Cape Hatteras, said the collision was quite similar to the collision of the Cushing.

OCTOBER WIRELESS AGE

WILL CONTAIN ARTICLES ON

Universal Honeycomb Lattice Windings

Dimensions of Inductance Coils

Some Pointers on Reconstruction

Some Electrical Guides for Wavemeter Design

By Oscar C. Roos

FELLOW I. R. E.

SYNOPSIS OF PRESENT INSTALMENT

General requirements of a wavemeter as compared with a receiver—wavemeters and receivers vs. "stiffness" of circuits—physical definition and examples of stiffness—effects of stiffness—general design relations in wavemeter coil and condenser—unilattice detector connection—general arrangement—anti-capacity switches—relation of wire in coil to wavelength—low coil capacity—spiral short-wave coils, sectionalized coils—use of spacers in winding—points concerning "bank winding" vs. universal winding—uses of bilattice universal winding in wavemeters—fixed multiple inductances—economy of wire in inductances—phantom antenna in wavemeters—general remarks on material to be used.

ANY receiver where the presence of the detector does not appreciably change the resonant wave length of the tuning circuit, may be considered to be a wavemeter, if it has a permanent calibration.

Such a wavemeter is shown in figure 1. In place of the usual crystal there is shown a thermionic relay FGP, as a resonance indicator. Its presence does not perceptibly change the resonance period of the oscillating circuit CL. This may be stated in a more technical way by saying that its reactance at radio frequencies must be between 50 and 1,000 times that of the coil L or the condenser C which has an equal reactance at resonance. For example, if L is 300 mh. and C. is .000337 mfd., at resonance the reactance of L is 9,425 ohms, which must balance 9,425 reactive ohms in the condenser in a negative or opposite phase. This occurs at 600 meters or 500,000 cycles. If the condenser C tunes down to .000085 mfd., giving about 300 meters, the effective capacity of the detector and its related series condenser C′ and grid leak R should not be greater than .000002 mfd. in order to avoid increasing the wavelength at 300 meters resonance by more than 1 part in 85.

With increasing wavelengths to be measured, this effect diminishes proportionally to the increase in wavelength, so that at 600 meters the detector has increased the wavelength by only 1 part in 170.

Reconsider the above problem from the standpoint of an inductance of 150 mh. or one-half the previous value. Our tuning condenser at any given wavelength would have twice its former capacity, and hence the relative disturbance in calibration due to the detector would be half its former value, i.e. at 600 meters it now amounts to one part in 340. To get down to 200 meters, we may have to cut down the value of L once more. This will give us, to get 600 meters, L = 37500 cm. and C = .0027 mfd. Now there are many condensers giving a capacity range of wavelength of four times the minimum. To do this, the minimum capacity must be 1/16 the maximum or .000175 mfd. In using this capacity, corresponding to 150 meters, the detector will make a difference in the wavelength of one part in 175 or about ½ per cent. Any further reduction of L to decrease this detector effect is unnecessary and is positively harmful, as it decreases the ratio of L to C, whose square root is a measure of the "stiffness" of the circuit, and this broadens the tuning.

EXAMPLES OF STIFFNESS

Stiffness in a wavemeter circuit is measured in resistive ohms and when large, it gives to an electrical circuit a slow, very persistent oscillation, such as a stiff spring exhibits when released suddenly. Take the above circuit as an example. When tuned for 600 meters its stiffness—the square root of L_h divided by C_f—is equal to the square root of .0003 henry divided by .000,000,000,337 farad = 942 ohms approx. This is the best tuning circuit, and by contrast with it, the last circuit above considered—having L = 37500 cm. and C = .0027 mfd.—has only ⅛ of its stiffness or sharpness of tuning between 600 and 150 meters. There is an advantage in having less coil resistance in proportion to coil inductance or what is known as a better "time constant" in the .0003 henry coil. The 37500 cm. coil always shows that its tuning is broader unless very special and expensive refinements are introduced in the design of the coils to reduce their resistance to the lowest possible degree. This point will be again brought up. When the 300,000 cm. coil is used, its stiffness at 600 meters is divided by 1.73, the square root of three, to get the stiffness at 200 meters. When the 150,000 cm. coil is used—the stiffness is .71 of what it was with the 300,000 cm. coil or about 680 ohms.

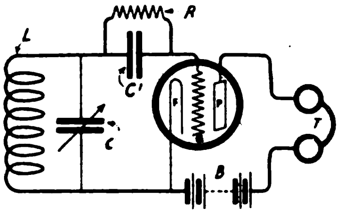


Figure 1

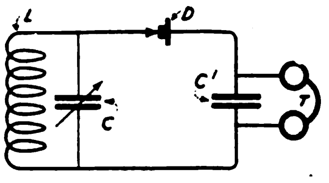


Figure 2-B

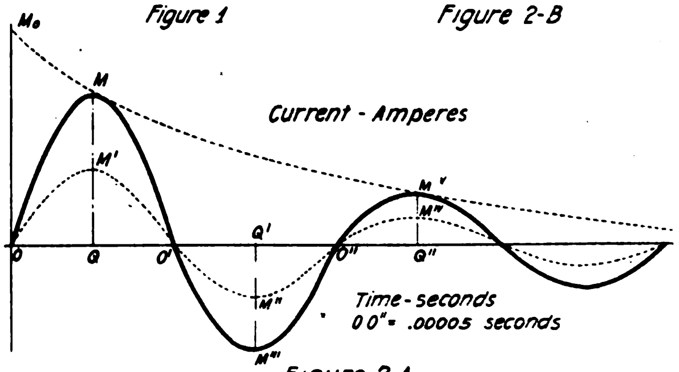


Figure 2-A

Electrical effects of stiffness in radio circuits

EFFECTS OF STIFFNESS

The user of a wavemeter naturally wants to know why so much attention is paid to "stiffness." The reason is that the property of stiffness in a measuring circuit reduces the change in resonant frequency that occurs when resistance is introduced into a theoretically free or undamped circuit. Hence, you often hear the expression "free period" of a circuit or "undamped" period or wavelength as contrasted with the "damped" or "natural" period or wavelength.

The greater the stiffness the less the effect of coil and condenser or wiring resistance on the "undamped" wavelength. Take the above 600 meter circuit L = 300,000 cm. C = .000337 mfd. It is fairly stiff, as we find that we may introduce about 150 ohms and yet only reduce the undamped frequency so that the "natural" wavelength is 608 meters instead of 600 meters. If we had L = 150,000 cm., C = .000674 mfd., and introduced the same 150 ohms the difference in wavelength would be four times what it was before—the natural wavelength or resonant wavelength—which is the same thing—would be 632 meters instead of 600.

If one introduces enough resistance—about 1,100 ohms—the first of these two circuits would cease to oscillate or "tune" at any frequency. In the case of the second circuit, 550 ohms would be enough to stop all oscillations. The experimenter should remember that inserting resistance has the same effect on wavelength that increasing inductance has, but the latter sharpens tuning while the former broadens it twice as fast. Hence the importance of low resistance to prevent great stiffness of circuit. In other words the resistance ohms must be low, the stiffness ohms must be high.

"But what is stiffness from the standpoint of something that can be physically measured or seen directly?" you may ask. Figure 2A is an attempt to answer this question.

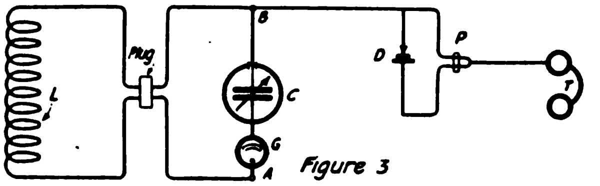


Figure 3

Elements of typical wavemeter circuit

It is intended to show that stiffness is physically an inverse measure of the first maximum current value in a damped electrical oscillation, from a discharged condenser. Figure 2A is the curve given by a Braun tube oscillograph of the current-time oscillatory discharge curve. The first maximum ordinate QM is inversely proportional to the stiffness when the resistance present has not appreciably changed the "undamped" wavelength.

The current QM is found by dividing a certain percentage of the voltage on the charged condenser by the stiffness of the circuit in ohms. If we have the discharge frequency in figure 2A of 500,000 cycles, so that the time represented by OO″ is one five hundred thousandth of a second (1/500,000), with L = 300,000 cm. and C = .000337 mfd.—the current maximum, QM, will be one ampere with proper resistance in the coil and, say 1,000 volts on the charged condenser. If we halve L and double C the stiffness is doubled and the new current maximum QM′ is one-half ampere. Similarly Q′M″ and Q′M‴ etc., are proportional to QM and QM′, so that in one sense, the stiffness of two circuits of the same period may be compared at any pair of current maxima, such as $Q''M^{iv}$, $Q''M^{v}$.

In figure 2B an extreme instance of stiffness is shown schematically in an ordinary wavemeter circuit, using a crystal detector in series with a head telephone. Figure 2B is inoperative unless the path through detector D and telephone T is reduced in stiffness, by shunting the latter by the condenser C′. The stiffness of such a path may easily approach a megohm with high impedance phones of 30,000 ohms at audio frequencies in series with the very small equivalent capacity of the detector D. This detector does not pass enough current to work well, until condenser C′ is shunted across the phones. It should be noted that some phones have sufficient capacity in their own windings to require across their terminals a very small condenser.

It is now evident that the most important precaution concerning wavemeter design—permanence of calibration—cannot be solved absolutely, on account of the inevitable changes in the detector. Practically any desired degree of accuracy at a given range can be obtained, as shown above, by making the circuit stiff and yet keeping the resistance down in the coil L and the reactance as high as possible in the detector.

General Design Relations in Wavemeter Coil and Condenser

It is important to have proper "overlap" from one range of wavelengths to another. With several detachable coils and a tuning condenser, it is necessary to have the first 10-20 degrees of the second range coincide with the last 10-20 degrees of the first range, and so forth in the remaining ranges.

The change of wavelength with fixed capacity and change of coil may be called l. It usually varies between 2 and 4. In a similar way the change in wavelength with fixed coil and variation of capacity may be called g. Calling the relative overlap "p" and recollecting that $g > 1$ and $h > 1$.

$$p = \frac{g-h}{g-1}$$

The above formula shows that letting the larger of two coils approach the smaller $h \doteq 1$—which means that h is greater than and approaches unity—and $p \doteq 100$ per cent.; in other words the overlap approaches unity as the coils approach each other in value. The value of g lies usually between 2 and 8. A good average overlap is given with

$g = 4$, $h = 3.4$, hence $p = 20$ per cent.

The less the overlap, in covering a given total range, the fewer coils and less wire are necessary.

It is very important to know the effective capacity of the wavemeter wiring itself. This may be as much as .000040 mmfd. in a portable wavemeter and more in others. It reduces the capacity range, g, given above, by as much as 65 per cent., with large values of g. The effective range is always less than the free range of the condenser.

Unilateral Detector Connection

The precautions regarding detector capacity illustrated in figures 1 and 2B give a sensitive detector connection, but do not give the sharpest tuning possible. The unilateral connection of the detector shown schematically with other improvements in figure 3, gives a response about one-seventh as loud as that given in figure 2B, under similar conditions, but much sharper. The energy caught in the detector is really that rectified in the radio frequency current from the fixed or high potential side B of the condenser C, through the detector D and phones T, and out into space as dielectric flux between the other side of the condenser C which is grounded to a metal shield S joined to the movable plates of C.

The phones T must not be near the shield S during calibration or use of the wavemeter. For this reason a detachable connection for the phone cords is suitable at P, in the form of plug and jack or else a clip. Both the detector D and plug P should be placed as far from S as possible. When this is done the continual change in capacity of phones due to change in position of observer is negligible. This is reduced to a minimum by above precautions and is well below the capacity allowance in the detector path, discussed under figure 1.

General Arrangement

The wavemeter should be capable of use as a transmitter or driver either by buzzer or triode (vacuum tube with three electrodes). With the latter we are not concerned here, but connecting a battery and buzzer in series to the binding posts A and B figure 3 gives a source of variable wavelengths.

The thermo-galvanometer or hot-wire instrument G should be inserted between the point A and the condenser

C. On no account should it be inserted between the point A and the coil L, as it would register the direct current in the buzzer. The advantage gained in the arrangement of figure 3 is that only oscillating current passes through G, which thus gives a relative measure of the efficiency of different buzzers, if run at a given audio and radio frequency with the same battery.

ANTI-CAPACITY SWITCHES

It is necessary to avoid ordinary cam-switches or the usual form of plugs and jacks for making connections. Both these forms of connection add appreciably to the capacity of the wiring and still further reduce the effective condenser wavelength range. At wavelengths of less than 600 meters they do not constitute the best practice. There are cam anti-capacity switches having less than .000002 mfd. capacity which are good down to 50 meters.

Where solid parts must be used as a dielectric instead of air for mechanical reasons, it is well to machine away as much of the solid as possible. This is especially true in tube and plate construction, where between 50 and 80 per cent. of the material may be removed, to reduce the dielectric loss. By doing this the capacity of a plug connector on a wavemeter detachable coil may be kept down to less than 1 mmfd.

If great refinement is required, it is better to evade the use of detachable coils and to use for all wavelengths the same set of fixed inductances arranged in different series-parallel combinations to get different ranges. A low-capacity drum-switch makes the necessary changes in the combinations and can be so designed that 80 per cent. of its volume is air dielectric. This will be taken up again under the subject of wire economy in design.

RELATION OF WIRE IN COIL TO WAVELENGTH

Both theory and practice warn against developing local oscillations in wavemeter coils, by tuning them to circuits oscillating near the exploring coil's fundamental frequency. Since a coil can vibrate at this frequency, when unattached to any other device, its tuning value is nil at this frequency, unless for wavelength checking.

In a plain or cylindrical winding the wire length should not exceed 4 per cent. of the shortest wavelength at which the coil is used, e.g. if this be 100 meters, not more than 13 feet of wire should be used. This means a small coil if the wire is to be used efficiently, by being wound in many turns, but the coil does not pick up as much energy at a given frequency as if only one or two larger turns were used, giving smaller inductance. We find also that with the latter arrangement there is an advantage of greater sensitiveness in "picking up" an oscillating field threading the coil L, which has, usually under these conditions, also smaller distributed capacity, relative to inductance. By making these few turns of very low resistance, fairly sharp tuning can be preserved, if the coil capacity is kept low.

LOW COIL CAPACITY

We have a safe rule for maximum length of wire advisable for a given coil-inductance and wavelength. If we reduce our coil capacity factor we may safely use more wire, more turns and get greater sensitiveness in the wavemeter. There are lattice wound coils with 330 meters of wire having a fundamental of about 1,700 meters which give great satisfaction, even though their length of wire is as much as 20 per cent. of their fundamental wavelength. This is possible because their distributed capacity is only about 13 mmfd. By using the bi-lattice winding, which will be described further on, this distributed capacity may be reduced to 10 mmfd.

In short-wave coils the best form is not the universal winding, but the sectionalized spiral coil, as with a given coil sensitiveness or reception factor, the coil capacity is less. This sensitiveness or reception factor is a measure of the emf. induced in a coil of area A having an inductance L and N turns and applies to any receiving loop or coil. The wavelength received, using a loading condenser, is λ, and the coil radio-resistance or resistance at radio frequency, is R. Calling the reception factor, "F,"

$$F = \frac{NAL}{R\lambda^2}$$

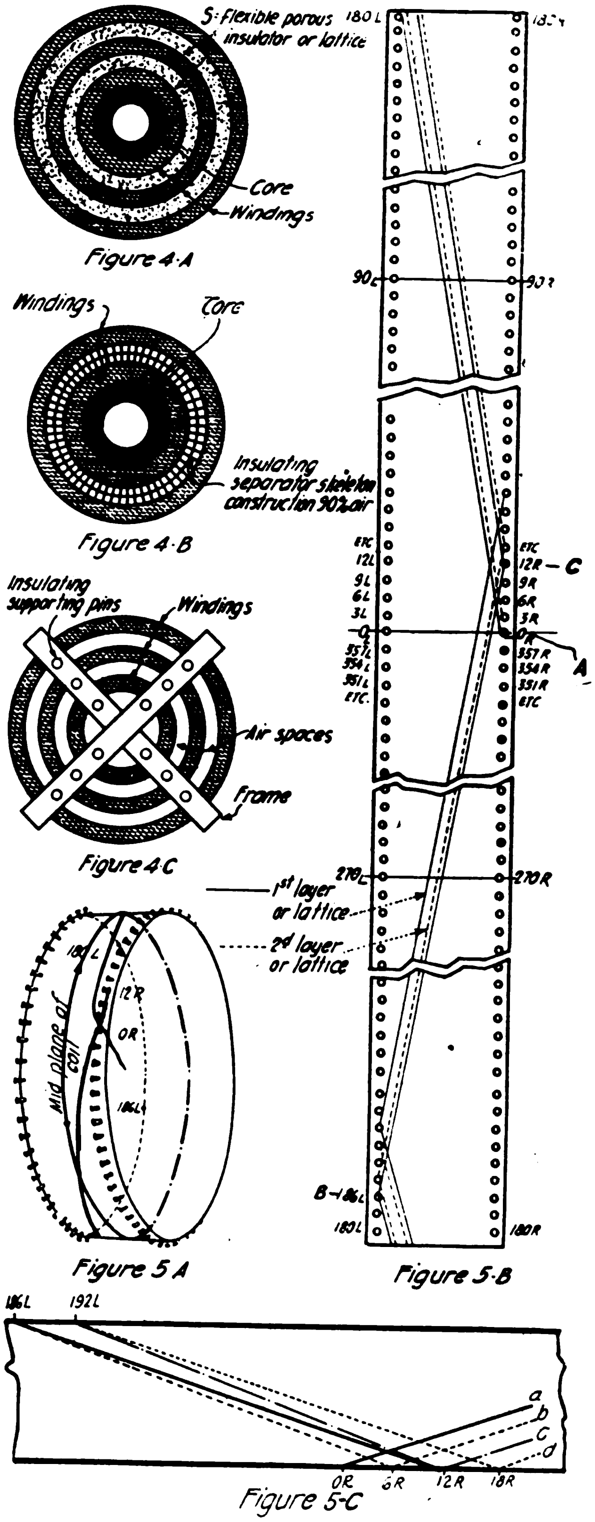


Figure 4-A

Figure 4-B

Figure 4-C

Figure 5 A

Figure 5-B

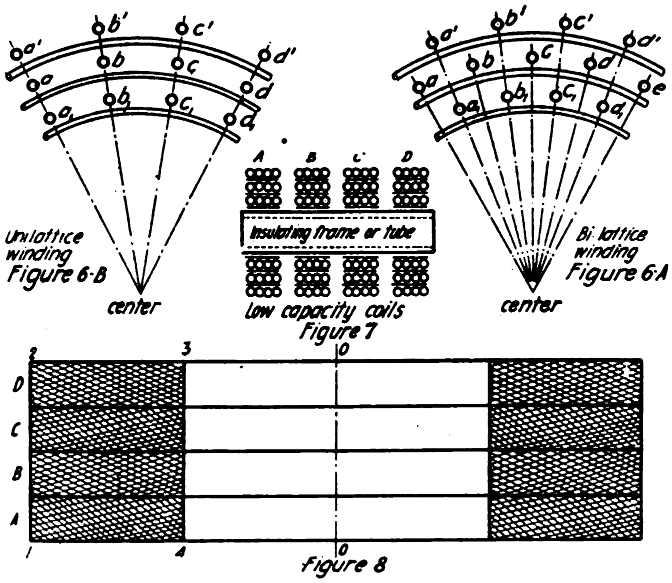
Figure 5-C

Methods of securing low coil capacitance

It is evident that for best coil efficiency, and sensitiveness, the same type of coil cannot be used in a high grade instrument for short and long wavelengths. Even the repeated use of the same windings in combinations of fixed coils for all wavelengths does not give as good a result on waves around 200 meters as the coils described below.

Spiral Short-Wave Coils—Sectionalized Coils

The best form of short wave coil is indicated in figures 4A, 4B and 4C. The common feature of construction therein is the pancake form, giving a ratio of thickness to depth of winding of not more than 1 to 4, and having the windings divided radially into three or more concentric rings separated by a porous or "latticed" dielectric. It is not generally known that a honeycomb or lattice dielectric equivalent to 50 per cent. air volume or better can be made from fine strips of flexible dielectric or from "strings" of same. Portable wavemeters for as low as 60 meters with a 4-Coil range of 60-3600 meters, were used by the Navy during the World War, having their short wave coils sectionalized as in figure 4A by coarse blotting paper S, shown by cross-hatching. The mean diameter of the coil was about 3½ inches, depth of winding 1¼ inches, and width varied between 1/16 inch—taking one turn per layer of Navy Standard, 3-16-28 Litz—and ⅜ inch. The separations are shallower, as they occur nearer the circumference of the winding. From 3/16 inch near the center they decrease to 3/32 inch near the circumference. This tends to equalize the capacity effect of each section, as the potential drop is sharper near the center of the coil.



Low capacitance coils, lattice type—figures 6-A; 6-B; 8. Morecroft type, figure 7

This sectionalizing reduces the inductance, but reduces the capacity to a greater degree, and the sharpness of tuning is improved. If two or three Litz wires are wound in parallel and there are 2n or 3n turns per layer where $n = 1, 2, 3, 4$, etc., we may reduce the resistance still further and thus sharpen the tuning. We should not have "n" greater than 3, giving 9 wires or 3 "turns" per layer, using the pancake coil, as we would have to enlarge the diameter of coil to keep the relative depth of winding the same. Wavemeter coils are best made of not more than 5 inch external diameter, for portable use.

When a coil is used for 200 meters wavelength or less, special care should be taken to avoid dielectric losses, and to get very low resistance. Figure 4C shows a means of accomplishing this. Here we have a coil sectionalized by air spaces, by the use of a coil frame. This method is hardly worth while for the experimenter who requires for 60 meters only about 5 turns, 3.5" mean diameter of Navy Standard Litz. He may just as well use a separator of blotting paper, using one turn per layer, but if he uses two or three Litz in parallel radially, i.e. one over the other, he will at the same time reduce the capacity between "turns" and also the resistance. The coil frame is electrically preferable, except for rough outside usage, to solid end-faces.

Use of Spacers in Winding

Detachable coils used between 200 and 600 meters give excellent results if a "spacer" or blind cord, to reduce capacity between turns, is wound simultaneously with them and removed before the wire is fixed in place with insulating adhesive. It is understood that a flexible dielectric separator is necessary between every layer. This reduces the capacity still more.

Points Concerning Bank Winding vs. Universal Winding

A knowledge of bank winding is assumed and also of the universal winding known as "honeycomb," which is one kind of lattice winding. Bank winding must be done by hand and cannot conveniently go above 6 banks, using Navy Standard Litz, for engineering reasons. The coil capacity is twice as great as that of the "honeycomb" winding but is about 20 per cent. more economical of wire for a given inductance and shape of winding cross section.

The universal winding can be built up into a true pancake form, rigid and dependable. Several shallow coils "universal-wound" may be used in the frame coil, shown in figure 4C schematically. But a shallow bank-wound coil of two banks is easily wound and is electrically satisfactory for medium waves, of about 450-950 meters. At longer waves it wastes wire compared with a universal coil of same distributed capacity.

If the best result is desired, regardless of cost, the experimenter should use the universal winding, either "bi-lattice" or "honeycomb" ("uni-lattice"). If he winds his own universal coils on any of the several "jigs" shown for that purpose in current technical periodicals, he has the satisfaction of knowing that they are superior to the machine wound product in at least one important respect, from his point of view—they have at every "swing" or "cross-step" of the winding, which occurs about every 180 degrees in lattice coils, a small semicircle of projecting wire which is of great assistance for "tapping" the coil, especially when of solid wire.

Uses of Bi-Lattice Universal Winding in Wavemeters

By a simple change in relative positions of adjacent "turns" or "circuits" in a universal wound coil, these coils have alternate lattice patterns which are "staggered" and the capacity thus reduced about 15 per cent. compared to the uni-lattice type. This effect can be obtained on a universal winding-jig used for "honeycomb" (uni-lattice) hand-wound coils, as follows: In figure 5A we have the schematic diagram of a drum intended to have a double row of radial pins 3 degrees apart at its right and left sides near the "faces." These pins are pushed upward as each layer is wound. Starting at A on the right at 0 degrees and turning the coil, the winding passes to 186 degrees on the left at B, a swing of 186 degrees coming back at 360 degrees plus 12 degrees or 372 degrees on the right at C. To follow the winding it will be convenient to adopt the following symbols.

From the right hand starting peg at 0 which we call Or, all pegs or pins, as the case may be, are called OR, 3R, 6R, etc., to show the number of degrees over which the winding has passed on that side. The symbols OL, 3L, 6L, etc., are similarly used for the left side. Let the pins, 0, 6, 12 etc. both R and L be one color and those on 3, 9, 15, etc. another color.

The lattice pattern indicated in figure 5A, is shown more in detail in figure 5B and the difference between a single wire bi-lattice and a double wire bi-lattice is indicated in figure 5C. In lattice coils it is better to call one revolution of the wire as laid down in a series of "cross-steps" a "circuit" instead of a turn.

Starting at OR in figure 5B we make a circuit plus 12 degrees at 12R. With 29 more circuits we have a "layer" before we arrive at OR again. This would be a uni-lattice coil. We make however, a 2-wire bi-lattice coil by winding simultaneously, another winding starting at 3R. Then we have a 2-wire, bi-lattice step-wound coil in contradistinction to possible spiral wound forms. (See article on Lattice Coils in General in July "WIRELESS AGE.") If the usual pitch is less than 360° (instead of 372° as above) we divide it—not 360° as above—by the advance, v, to get the "circuits" per "layer." If we had started in figure 5B at 6R instead of 3R or 9R we would have had the type of winding shown in figure 6A, which is more efficient.

The most efficient winding is obtained where the wires in figure 6A examined in sets of four, such as a^1 b a_1 a form a square. This does not give the best inductance-volume efficiency, but the tuning efficiency factor

$$\frac{1}{R}\sqrt{\frac{L}{C}} \text{ is greatest.}$$

In figure 5C we see the winding design factor come into play, turning a uni-lattice coil into a single wire-bi-lattice. The choice is made on leaving the last step (186L) before making a circuit at 12R. Passing from 12R along wire "a" gives the uni-lattice winding, but going back or "slipping" half the advance or 6° we start a bi-lattice at 6R and wind exactly as before, making a second "circuit" if we do not "slip" at 18R–"d." But we must again "slip" to 12R and we have for one more "circuit" the original lattice. So we build up two lattices with one wire. If we had "slipped" back 9° to 3R for one circuit and no degrees to 12R on the next, then 9° more to 15R, etc., we would be reproducing the 2-wire bi-lattice pattern in figure 5B with a single wire.

The staggering of the wiring to reduce mutual capacity in the bi-lattice coil is shown in figure 6A where the layer $a'b'$ etc., and the layer a_1b_1 etc., have the same circumferential positions at the pins, but where the layer a, b, etc., is displaced 3 degrees from both the above layers. The ordinary uni-lattice winding or honeycomb construction is shown for comparison at figure 6B.

ECONOMY OF WIRE IN INDUCTANCES

The smaller the "swing" or the angle passed over in one "cross-step" in a universal coil, the lower the inductance; the greater the copper waste per turn, but the less the capacity up to a certain limit. The ideal "swing" for wire-saving alone, would be close to 180 degrees, but not very close; as the capacity would increase too much. The mathematical solution for best pitch is impracticable and the experiment derivation of a formula is contemplated, which depends on the swing, s, and the width, w, of the winding compared to its depth, t.

FIXED MULTIPLE INDUCTANCES

To save wire, the arrangement of several low-capacity coils, as shown in figure 7 has been used in receivers and wavemeters. In most cases the various sections A, B, C and D were not all used throughout the scale; as they should be, to get the greatest economy in wire, other things being equal. With the coils in figure 7 the equivalent of 4 detachable coils can be obtained by the following combinations, secured by a properly designed drum switch.

Let "+" mean "in series with"
Let "—" mean "reversed normal series connection"
Let "×" mean "in multiple with"

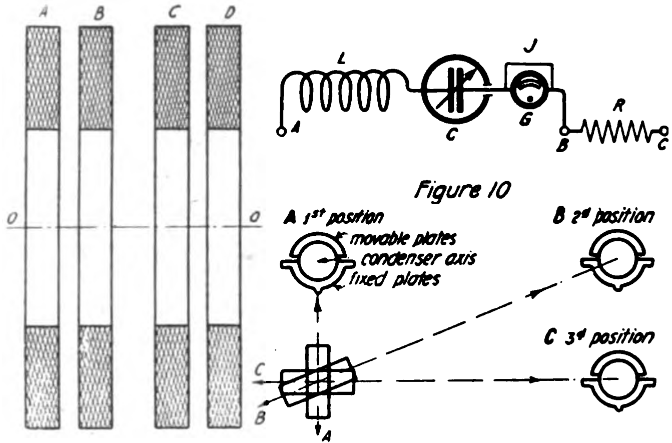
There are four ranges obtainable as follows:

Range I — $A \times B \times -C \times -D$
Range II — $A \times B \times C \times D$
Range III — $A \times B + C \times D$
Range IV — $A + B + C + D$

In Range I, A C oppose, also D and B oppose, B and C also oppose, but the system can be used even when the mutual action between B and C is but a fraction of that between A and B or the similar pair C and D.

The range in wavelength of such instruments as the above is as high as 1 to 25. This is not as good as a range of 1 to 60 obtainable in four coil instruments, of the detachable type. There is a saving of about 30 per cent. of wire over the detachable coil type of wavemeter, having approximately the same range and overlap.

It is necessary to remember that although in range I the windings have a large capacity relative to their inductance, i.e., small "stiffness," yet the coil efficiency is good on account of the lower resistance with windings in parallel. In other words the efficiency factor $\frac{1}{R_1}\sqrt{\frac{L_1}{C_1}}$ is large where L, C and R are average inductance, capacitance and resistance per centimeter.



Refinements in wavemeter design

It is obvious that a multi-lattice coil permits the starting or stopping of a new possible winding at any point in the coil. In figure 5B, we might start several windings according to coupling requirements, at 2R, 4R, 6R, 8R or 10R at various "layers" of the coil and stop them at any others.

The fixed coil type has an overlap of 83 per cent. in some cases, whereas 17 per cent. would be sufficient, if only receiving measurements are usually to be taken. The wire expense for a given range may be thus reduced by about 80 per cent; as this expense is roughly proportional to the overlap in a given range. With four coils the range would roughly increase inversely as the cube of the overlap; i.e. if we cut the overlap from 80 per cent. to 40 per cent. by using larger coils, the range of the instrument will increase about 8 times.

When the overlap is more than 50 per cent., different degrees of tuning are practical, and when driving another circuit, the character of the waves at a given wavelength may be changed with respect to damping. Otherwise large overlap is a positive defect in its heavy waste of wire.

The best compromise between overlap, coil and condenser-range and economy of wire in a given total range has been analyzed practically, but must constitute another article. It is sufficient to show how pancake universal wound coils can be adapted to the construction indicated by figure 8.

In figure 8 four coils A, C, B and D are placed together to form a unit, whose resultant cross section of winding is a square 1, 2, 3, 4 giving the best "time constant" or greatest inductance for a given length of wire. This "Maxwell" coil is obtained when 1-4 is one-half the coil radius.

When these coils are moved apart axially, as shown in figure 9, if the spacing between them is varied, a wide range of overlap and range without disconnecting the coils may be obtained. With wider range there is, of course, less overlap. Separating the coils increases the overlap and reduces the range.

PHANTOM ANTENNA IN WAVEMETERS

The circuits in the wavemeter should be arranged so as to permit its use as a "phantom antenna," by "shorting out" the indicating instrument G by the "jumper" J and by inserting external resistance R as shown in figure 10.

This can be easily done by a 12 point D.P.D.T. anti-capacity cam-switch, so that the first position is "receiving," second position is "dummy-antenna" and third position is "transmitting." Navy Portable Wavemeter Type 614-A was thus designed by the writer.

Exact fundamentals can be obtained with such wavemeters of coils or antennae without approximations due to "single turns" of coupling-wire or large series condensers.

GENERAL REMARKS ON MATERIAL TO BE USED

Condenser leakage paths should be at least one inch. Unemployed windings should be avoided or "shorted." Fixed coils as shown in figures 8 and 9 should if possible, be arranged with their mid-planes passing through the condenser axis. This mid-plane is the weakest part of the coil field. The greatest distance consistent with small wire-capacity and inductance should separate coils and condenser. Of the three condenser positions shown in figure 11A,B,C—the first is the worst and the second the best as far as coil-action on the condenser is concerned, but low capacity in the winding requires the use of the arrangement A in most cases. Hard rubber not exposed to the air is better than bakelite or similar compounds electrically. Its progresive surface leakage is against it, especially as it decomposes gradually under the influence of moisture and light. For general use Bakelite and Formica are satisfactory. Pyrex condenser mountings for very fine work are excellent.

The above are some of the considerations which in the main have been experimentally confirmed and form the nucleus of a systematic engineering treatment of various special wavemeter problems. From actual cases, tables have been compiled, which it is hoped to give in these columns.

Transmitter for Use on Direct Current

DURING 1915 and 1916 amateurs in the vicinity of New York City were familiar with the spark of two or three stations, such as "2 PM," which at that time were using what Walter S. Lemmon terms a resonant converter in a device which he has recently perfected.

The figure represents an arrangement of sending circuits of a radio transmitter in which a synchronous spark gap and an associated rotary controller are used; the rotary controller or commutator serving to make and break a direct current circuit. The source of D. C. is connected through an adjustable resistance R (whose function is to limit and control the supply energy) to an oscillatory circuit containing the commutator C, inductance I (which is the primary of the transformer) and the condenser L. It will be observed that the direct current source is so connected to the oscillatory circuit as to apply the direct current energy to two circuits, one of which contains the commutator and the other of which contains the inductance and capacity. In other words, the oscillatory circuit is, in its relation to the direct current source, made up of two parallel paths, one of which, containing the inductance and capacity, is capable of absorbing energy from the direct current source when the direct current through the commutator is interrupted; and the other of which affords a very low resistance path for the direct current when the circuit through the commutator is closed, which path also provides a short circuit for the oscillatory circuit.

With the parts thus arranged, a rotation of the commutator will periodically interrupt one parallel path causing the direct current to be shunted into the other parallel path containing the inductance and capacity, thereby storing energy in this portion of the circuit. When the commutator brush has passed over the insulation segment and comes upon the next conducting segment, the closed circuit is completed and the stored energy will discharge itself through the closed circuit, and if the circuit through the commutator remained closed, would, because of the inductance and capacity in the circuit, give rise to damped electrical oscillations. If, however, the speed of rotation and the design of the commutator is such, that the circuit is made and broken at intervals, which corresponds substantially to the natural frequency of the oscillatory circuit, then the change of circuit connections will be effected substantially without sparking and an alternating current of constant amplitude will flow into the transformer primary. Consequently, energy in the form of a constant amplitude alternating current may be taken from the circuit through the instrumentality of the transformer secondary which may be included in the ordinary spark gap circuit of a radio signaling system.

The closed resonant circuit contains a telegraph key and the secondary S, is included in the spark gap circuit which is inductively associated through the transformer with the antenna. In this case, a synchronous spark gap is used in the spark gap circuit. This apparatus may have any well known form, and should be driven in synchronism with the commutator. By way of example, a rotating disk G, is mounted on the same axle with the controller C, and carrying radially arranged spark points co-operating with two fixed spark points located at extremities of a diameter of the disk. The rotating disk G, may have the same number of spark points as the rotating controller C has pairs of segments and hence where these two devices rotate at the same speed, only alternating half waves of the alternating current are used for sparking. Both half waves of the alternating current can be utilized, thereby producing two sparks per cycle by doubling the number of spark points on the disk, G, or by rotating the disk G at double the speed of the controller C.

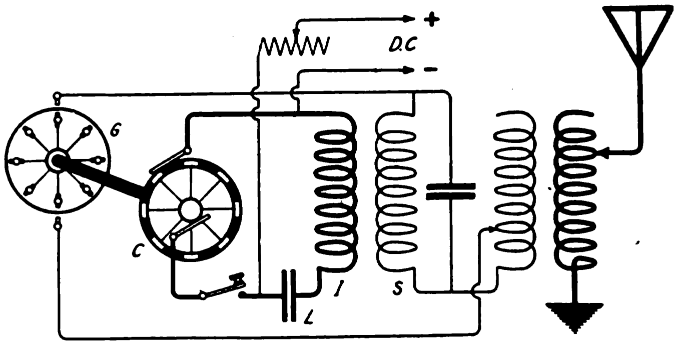


Figure 1—Diagram of connections for direct current transmitter

Modulator for High Power Work

A MEANS of controlling the great powers in accordance with vibrations of the human voice has been worked out by E. F. W. Alexanderson. In a previous article which was reviewed in this magazine, Alexanderson described a system of modulation in which a comparatively large amount of energy might be controlled by means of the feeble current set up in an ordinary telephone transmitter, wherein the amount of energy transmitted to the antenna from a local source of high frequency current was varied by means of an electron relay device controlled by the current from a telephone microphone in such a way as to vary its conductivity.

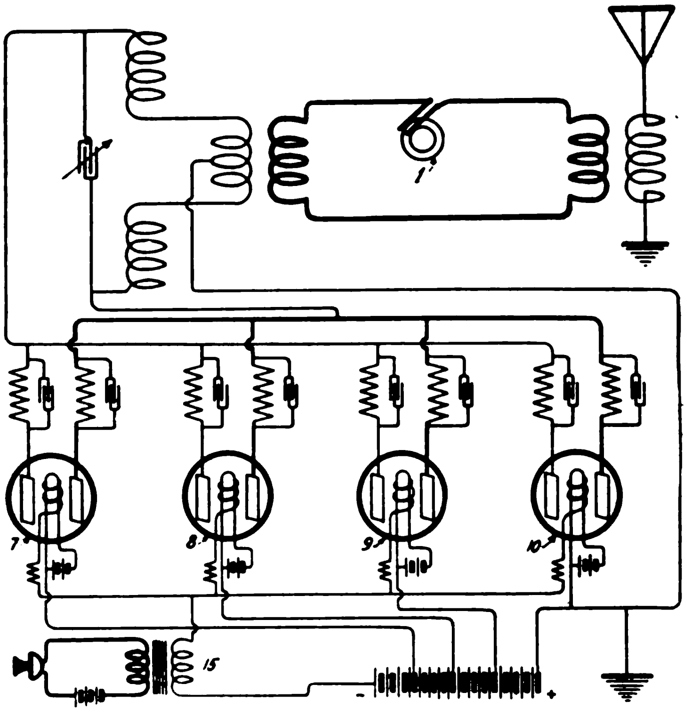


Figure 1—Circuit diagram showing hook-up

With this arrangement, in order to produce the desired variation in the antenna, the absorption of a considerable amount of the total energy of the local source in the relay circuit was unavoidable, the greater part of the energy being absorbed in the relay itself. Hence the amount of energy which might be effectively communicated to the antenna was limited by the absorptive capacity of the relay used. At the present time this capacity is limited by difficulties which appear to be inherent in the manufacture of apparatus of this type. The energy which may be controlled in such a system might be increased by connecting several relays in parallel, in which case the amount which could be controlled would vary directly as the number of relays used. By connecting the relays in parallel with resistance in series, in accordance to Alexanderson's latest invention, however, the amount of energy which can be controlled will vary substantially as the square of the number of relays used.

The drawings herewith show diagrammatically a system of connections whereby the desired result may be accomplished. A source of high frequency energy is connected through the usual transformer with the antenna. The primary of an oscillation transformer is also connected in series with the source of radio frequency energy and the primary of the transformer. The terminals of the secondary of the oscillation transformer are connected to the anodes of a series of electron tubes or relays through resistance as shown. These relays also contain filaments which are provided with a source of current for heating them. The filaments are surrounded by a grid as is usual, and the grids are all connected to one terminal of the secondary of the microphone transformer and to the other terminal is connected a battery. The filaments are connected to various points in this battery. One end of the battery is preferably grounded. The primary circuit of the microphone transformer includes a battery and the microphone. The filaments are also connected to the middle point of the secondary of the oscillation transformer 5. An adjustable condenser is preferably connected across the terminals of the secondary of the oscillation transforme, although in some cases the capacity of the relay tubes may be of sufficient order as to make this unnecessary.

With the arrangement here shown, it will be seen that the current in the antenna will vary in accordance with the current through the primary of the oscillation transformer. The amplitude of the current in the primary will in turn depend upon the current flowing in the secondary. It will be apparent that a certain portion of the energy from the source will be diverted to the secondary circuit and absorbed in the resistances and relay device therein. The system may be so designed and adjusted that the energy thus absorbed will in general bear a certain ratio to the total amount of energy derived from the source 1. Hence, by varying the amount of energy absorbed in the secondary circuit the amplitude of the antenna current will be varied in substantially the same proportion.

In a form of relay indicated in the present case, there will normally be a flow of negative electricity from the filament to the anodes but no flow of current in an opposite direction. The amplitude of the current flow through the relay may be varied by varying the potential impressed upon the grids. If a large enough negative potential is impressed thereon, the flow of current will be stopped altogether. If a positive potential is impressed upon the grids, the current flow will be increased. For convenience of description, let it be assumed that the potential of the grid is such that little or no current will flow through the relay when the high frequency potential of the secondary of the oscillation transformer is applied to the electrodes. The negative potential of the grids of the relays 8, 9 and 10, with respect to their filaments will be progressively greater. If now a current wave is produced in the microphone transformer of such a direction as to overcome the negative potential of the grids, current will begin to flow first from the relay 7 and will gradually increase to a maximum value. If the potential of the current wave is great enough, it will gradually overcome the negative potential of all of the grids and the current will begin to flow successively in relays 8, 9 and 10. When the voltage impressed upon the grids from the microphone transformer begins to decrease, the reverse action will take place, that is, current will cease to flow first in relay 10, next in relay 9 and so on, until the impressed potential falls to zero and no current will flow, as in the beginning. The relays may be so designed and the potentials applied thereto so chosen that when the current in relay 7 reduces its maximum, current will begin to flow in relay 8 and when the current in relay 8 reduces its maximum, current will begin to flow in relay 9 and so on.

Relay devices of the general type shown herein vary somewhat in their characteristics and in some cases the proportionality between the current flow and the voltage impressed upon the grid is constant only over a somewhat limited range. In such cases it may be desirable to so choose the potentials applied to the grids that before the current in one relay has reached its maximum, current will begin to build up in the next relay and so on. In this way the system may be so designed that the current flow therein will be substantially proportional to the voltage variation in the transformer 15 throughout the entire range.

When the current first begins to flow in the relay circuit the greater part of the drop in potential will occur in the relay itself and hence the relay will be called upon to absorb most of the energy of the secondary circuit. As the current increases, however, the drop through the resistances will increase and the proportionate amount of energy absorbed by the relay will decrease. The maximum energy which the relay will be required to absorb will be when the current has reached one half of its maximum value and the relay is consuming one half of the voltage. When the current reaches its maximum value in the relay the amount of energy which the relay will be required to absorb will be practically negligible, the principal drop being in the resistance.

Suppose, for example, that it is desired to control in the secondary circuit a maximum of 10 kilowatts of energy which may be represented by .5 ampere at 20,000 volts. If we do this with a single relay and secure a gradual regulation of the energy from no load to full load, the relay will be called on to consume a maximum of .25 ampere at 10,000 volts or 2.5 kilowatts. It will also be required to absorb energy during the entire period during which the change from minimum to a maximum takes place.

Suppose now it is desired to control a maximum of 160 kilowatts of energy which is represented by 8 amperes at 20,000 volts. If we use four relays as indicated in the drawing each relay will be called upon to take 2 amperes. The maximum amount of energy which any one relay will be called upon to absorb will be 1 ampere at 10,000 volts or 10 kilowatts. The change from minimum to maximum in each relay, however, will occur in one-quarter of the time required in the case where a single relay was used. Hence the average amount of energy absorbed will be only one-quater of 10 or 2.5 kilowatts. Thus it will be seen that four relays of the same capacity will be able to control 16 times as much energy as the single relay.

In the type of relay here shown there is an appreciable capacity between the anodes. This results in considerable current flowing through the relay between the anodes when the system is not being used for transmitting signals. As a result a large amount of energy is needlessly wasted in the resistances. In order to avoid this it may be desirable to shunt each of these resistances by a condenser. This will cut down the high frequency alternating current but will not interfere with the unidirectional flow of current through the relay between the cathode and anodes. It will of course be understood that the resistance may equally well be inserted in series with the cathode instead of in series with the anodes. In order to prevent the grids from consuming an unnecessary amount of current when they become highly positive, resistances may be inserted in series therewith.

Direction Finder

A NOVEL electromagnetic-wave navigational system developed by James Urskine-Murray and James Robinson, has been disclosed recently.

The direction of propagation of electromagnetic waves emitted from an external source may be determined by varying the orientation of a conductor in an oscillating field produced directly or indirectly at a receiving station by the waves. This conductor may conveniently be a closed coil in series with a condenser forming a tunable circuit and connected with a suitable receiver. Owing to the fact that the strength of the received current or signal varies more rapidly when the coil is turned in the neighborhood of the position of zero or minimum induced current, it is usual to determine the direction of the waves by varying the orientation of the coil until this condition is obtained. The orientation of the axis of the coil for minimum signal then indicates the direction of propagation of the waves.

This method has the disadvantage, firstly, that it is impossible to read the signals when on the position of minimum strength and secondly, that it is not suitable for use in aircraft or any other situations in which extraneous noises make it difficult to determine the actual minimum of the signals, since these are, in general, very weak in the neighborhood of the minimum and may appear to die away altogether at a substantial angular distance on either side of it.

Again, if an attempt is made to determine the minimum by turning the coil from side to side between the positions of equal signal strength, these are very difficult to distinguish owing to the gradual increase of strength as the coil is moved away from the minimum, rendering it impossible to make a direct comparison of two reasonably strong signals. The Murray-Robinson invention provides a means whereby the intensity of the signals at two points, one on either side of the minimum, may be directly compared by cutting out signals of intermediate intensity.

The invention provides means whereby the rotatable coil of a directive reception device and its pointer or indicator are free to move with respect to each other within determined limits, contacts being provided to constitute the limiting stops and also complete the receiving circuit.

The pointer is movable relatively to the rotatable coil over a certain angle which is determined by the positions of the stops and its position determines the limits of the angles which the rotatable coil can form with the direction line of the signal. The invention is equally applicable to a direction finding system comprising an electromagnetic coupling device, such as a radio-goniometer, in which case, the indicator stops determine the limits of the angles which the rotatable coil or condenser can form with the two fixed limits of the apparatus.

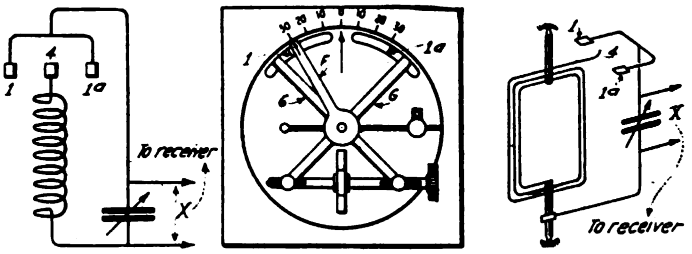


Figure 1 Figure 2 Figure 3

Circuit, plan view of indicator, and diagram of loop in position

It will be seen that by this invention, signals will be audible only when the rotatable element is in contact with either of the studs or contacts and that if the pointer or indicator be moved until equal intensity of signal is observed at two stops—the minimum intensity direction line must dissect the angle contained between the two positions as the intensity of the incoming waves varies according to the distance from the source and other factors—the distance apart of the stops is preferably adjustable.

In order that the construction and action of the invention may be more clearly understood, reference is made to the accompanying drawings in which figure 1 is a diagrammatic representation of the wiring as used either directly on a loop aerial or the movable coil of a radiogoniometer. Figure 2 is a plan view of one form of indicator in accordance with this inventor, showing the mechanical details of construction. Figure 3 is a diagrammatic perspective view corresponding with figure 1.

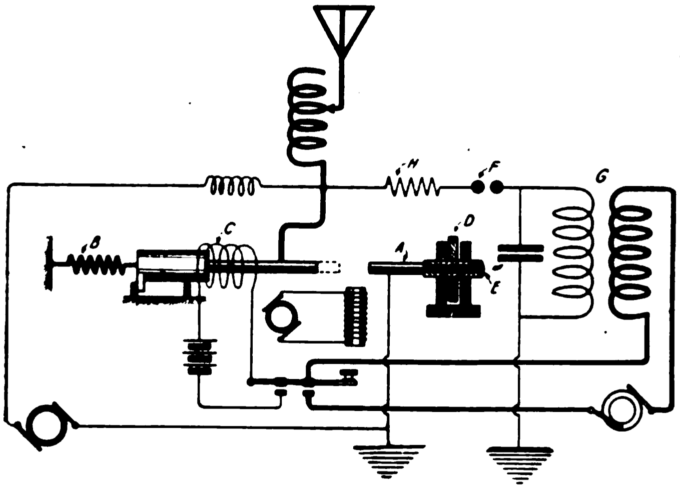
In figures 1 and 3 the two contact stops 1, 1^a, are jointly connected to one side of the tuning condenser the other side of which is connected to the aerial coil or rotatable radiogoniometer coil, the circuit being completed by contact 4 and either of contacts 1, 1^a. The receiver or amplifier is connected in any suitable method as by leads X across the condenser.

In figure 2 a rotatable disk is mounted on a base, provision being made to clamp it in any desired position by means of a clamping screw. A scale marked off in degrees is provided on the base around the disk. Two contact arms G are centrally mounted on the disk and their distance apart is adjustable by means of a left and right hand screw having a central bearing. A contact arm F rigidly connected with the rotatable aerial coil or rotatable radiogoniometer coil and forming one terminal of its winding, is rotatable about the same axis as the disk between the contact stops.

In using such an apparatus as a direction finder, the pointer—and with it the rotatable aerial or radiogoniometer coil—is rotated about the common axis of the apparatus until the pointer is midway between the contact stops. The disk is unclamped and rotated, carrying with it coil, pointer and contact, while the pointer is simultaneously oscillated between contacts 1 and 1^a until a position of the platform is found at which signals are of equal intensity with the pointer in the two limiting positions against the stops 1 and 1^a. If the pointer is then set midway between the stops it will give the direction of the electromagnetic waves producing the signals, and the actual bearing of the transmitting station can be readily ascertained.

Methods of Signaling with an Arc

CONSIDERABLE attention has been given by prominent radio engineers to the problem of controlling the arc generator with nicety at telegraphic speeds. L. F. Fuller discloses still another method of interrupting and re-establishing the arc by varying the length of the arc gap. The drawing printed herewith is a diagrammatic representation of the signaling scheme. The transmission system comprises an arc oscillation generator including the electrodes between which the arc is formed. One of the electrodes, preferably the negative electrode A is grounded and the other is connected to the antenna through a variable inductance. Direct current is supplied to the arc radio generator by a D. C. generator and the choke coil is arranged in the lead which connects the generator to the negative electrode of the arc. The arc is subjected as usual to a strong transverse magnetic field produced by magnet coils located adjacent to the arc. These coils may either be separately excited or arranged in series with the generator and the negative electrode.



Diagrammatic representation of the signaling scheme

Signaling is accomplished by igniting the arc and subsequently extinguishing it by increasing the distance between the electrodes, the distance being preferably increased by moving one of the electrodes. In operation, the length of the arc gap is increased to such distance that the arc goes out and subsequently the length of the gap is decreased to its proper oscillating arc length and the arc is re-established by a spark or other means. These operations are performed automatically and at telegraphic speed, and signaling is accomplished with a transmission key in the usual manner.

Secured to the negative electrode and insulated therefrom is a solenoid core which is movable in a direction to increase the length of the arc gap by a spring and is movable in the opposite direction by the effect of the current flowing in the solenoid C. The solenoid is arranged in series with a battery and a signaling key, which, when depressed, closes the circuit and causes the negative electrode to be moved to shorten the arc gap to its proper oscillating arc length. An ear projection on the core of the solenoid makes contact with the stop as the core moves forward and stops the electrode so that the proper oscillating arc gap is produced. A second stop halts the electrode on its backward movement. As the electrodes wear, the length of the arc is adjusted to preserve the proper oscillating length by a nut D engaging the screw E, secured to the normally stationary electrode A, the nut being placed between two stops in such a way that the electrode is moved longitudinally by rotation of the nut.

Connected across the arc is a spark circuit containing a spark gap, the secondary of the transformer G and the capacity which shunts the secondary. A stopping resistance H is arranged between the spark gap and the antenna side of the arc to prevent direct current sufficient to maintain an arc across the gap F from following the radio frequency current across the spark gap and passing through the secondary.. The primary of the transformer is in series with the alternating current generator and a switch connected to and insulated from the key. When the key is closed the electrodes are brought together and simultaneously the circuit through the primary of the transformer is closed, producing a high potential in the spark circuit and producing a spark across the spark gap which sets up radio frequency surges which ignite the arc.. When the key is released, the spring B by virtue of the energy already stored up in it, increases the length of the arc up to that point where it is extinguished.

The articles on the foremost high-power stations now appearing in the WIRELESS AGE merit the attention of all operators.

Improved Oscillator

F. K. VREELAND describes an improvement in electrical oscillators of the vacuum tube or electron relay type, whereby a greatly improved operation is secured, particularly in the matter of purity of the wave form. He has previously described a method and shown apparatus for generating sustained oscillations by utilizing either an electrostatic or an electromagnetic field excited by the oscillations to control the flow of energy in a vacuum tube or other sensitive gap in such a manner that increments of energy are supplied to the oscillating circuit in synchronism with the oscillations. One form of the invention specifically described utilizes "the effect of an electrostatic field upon the discharge of cathode particles in a vacuum tube" as a means of electrically communicating energy in a tube in such manner as to add energy to the oscillating circuit in synchronism with the oscillations.

In recent years great improvements have been made in thermionic tubes, whereby the effect of an electrostatic field set up between the cathode and a third control electrode, or grid, controls in a highly efficient manner the flow of energy between the cathode and the anode. This apparatus is so associated with an oscillating circuit that the oscillations act through the control electrode to produce the electrostatic commutating field and the variations in anode current thus produced supply high energy to the oscillating circuit.

In the vacuum tube oscillator as ordinarily employed today, a three electrode thermionic tube with its appropriate source of direct current energy is coupled to an oscillating circuit with a feed-back connection, whereby the flow of energy through the tube is controlled by the oscillations, and energy is supplied to the oscillating circuit in synchronism with the oscillations. Ordinarily the oscillating circuit is directly connected to the thermionic generator tube, the feed-back connection being associated with this circuit in any one of several ways.

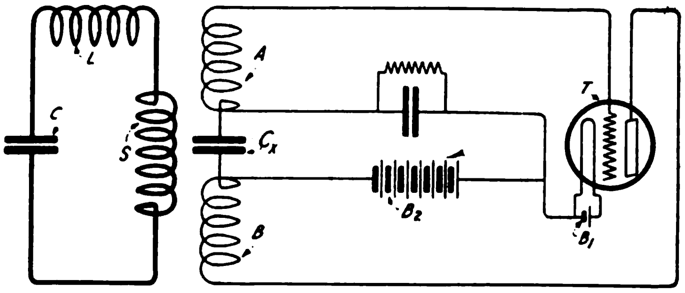


Figure 1—Showing inductive coupling of the oscillating circuit to the generator circuit

The result of this arrangement is an oscillating current whose wave form is very far from sinusoidal. This is due to the fact that the wave form of the energy supplied is not itself sinusoidal, and the disposition and the proportions of the oscillating circuit are such that it is incapable of smoothing out harmonics. As a consequence, when it is desired to secure an approximately pure wave form from such a device it is usual to employ filters or other equivalent devices to sift out overtones.

Vreeland's invention provides means whereby a current wave of great purity may be secured directly without the use of filters or other extraneous apparatus.

An oscillating circuit when fed by a source of energy whose wave form is not sinusoidal will execute approximately pure sinusoidal oscillations only if its inductance and capacity reactances are large with respect to the other impedances of the system with which it is associated. The thermionic tubes ordinarily employed possess, usually, a high and sometimes a very high impedance and it is usually impracticable to construct an oscillating circuit of sufficient reactance to be a "stiff" oscillator when connected directly to such a tube. By means of the present invention it is possible to use an oscillating circuit of moderate capacity and inductance reactance which is nevertheless capable of oscillating with very pure wave form. The requisite stiffness of the oscillating system is secured by coupling the oscillating circuit to the tube and its associated circuits by a stepdown coupling whereby the effective impedances of the tube circuit, as affecting the oscillating circuit, are greatly reduced and the distortions of wave form of the energy supplied are minimized.

In the drawing, figure 1 shows the circuit arrangements of one embodiment of the invention in which the oscillating circuit is coupled to a generator circuit by an inductive coupling. Figure 2 shows an arrangement in which an electrostatic coupling is employed.

In the arrangement of figure 1, T, is a three-electrode thermionic bulb having the usual hot filament with heating battery, anode and grid or control electrode. The tube or generator circuit includes the inductance coils A and B, the latter connected to the anode and the former to the grid which by their mutual inductance accomplish the usual feed-back function, the anode and grid being connected to points of opposite potential and the filament to an intermediate point. The generator circuit is completed through a stopping condenser Cx across which the anode battery B-2 is connected.

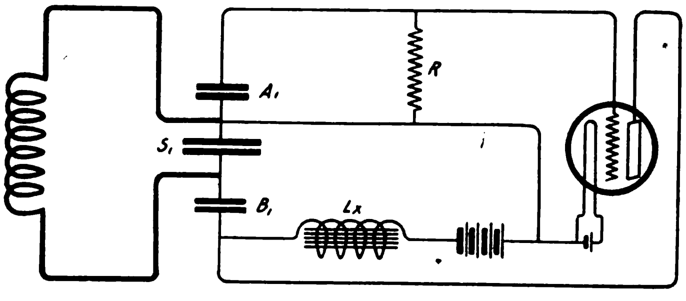


Figure 2—Showing electrostatic coupling

The oscillating circuit is connected to the generator circuit through inductive coupling of the coils A and B to the secondary coil S, having a relatively small number of turns, whose circuit is closed through the main capacity C and inductance L of the oscillating circuit. The coil S is preferably closely coupled to the coils A and B. By virtue of the step-down action of the transformer A, B and S, the oscillating circuit may be made a stiff oscillator with moderate values of inductance and capacity reactances while the close coupling provides an efficient energy transfer.

By a close coupling is meant a coupling whereby the coil S embraces the major portion of the field of the coils A and B, thus making the generator circuit practically aperiodic and subject to the frequency control of the oscillating circuit. The effect on the oscillating circuit, however, is equivalent to a loose coupling, inasmuch as the inductance of the coil S is small compared to the inductance L. The oscillating circuit is therefore effective in selecting oscillations of its own frequency to the practical exclusion of other frequences, notwithstanding the relatively small absolute values of its reactance while the reactances of the coils A and B may be made comparable to the tube impedances, thereby providing an efficient energy transfer. Figure 2 shows a purely electrostatic coupling. Here the generator circuit includes condensers A-1 and B-1 of reactances comparable to the tube impedance, and a third condenser S-1 of relatively small reactance which serves as a step-down electrostatic coupling between the generator circuit and the oscillating circuit including the coil.

EXPERIMENTERS' WORLD

Views of readers on subjects and specific problems they would like to have discussed in this department will be appreciated by the Editor

A Laboratory Radiophone

By Allen H. Wood, Jr.

THE amateur of today is fortunately in an advantageous position to build and successfully operate a radiophone. Formerly, inability to buy vacuum tubes and other constructional parts proved a serious handicap to the wireless enthusiast, and rather than go to the necessary trouble of locating and building the various parts of a radiophone, he devoted his time and money to the construction of conventional spark transmitters. Many of the amateurs would gladly have devoted the time and trouble necessary to construct the apparatus, but information was lacking in regard to details. Conditions have so changed that at present, all the necessary material and information for the construction of a wireless telephone is readily obtainable.

The radiophone hook-ups offer three distinct forms of communication: voice, buzzer modulated telegraphy, and continuous wave telegraphy.

It is the aim of this article to give a detailed description of a radiophone embodying the three forms of communication mentioned above. This phone will radiate about .5 of an ampere and with the average antenna will have a speaking range of thirty to forty miles depending upon local circumstances. The telegraphic range of the same set will be much greater in the case of buzzer modulation and still greater when continuous wave radiation is employed.

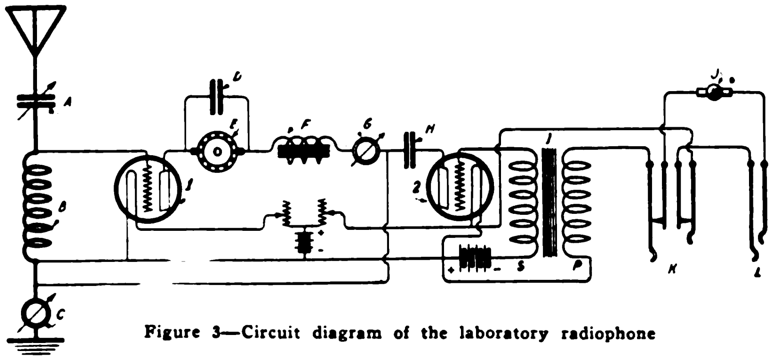


Figure 3—Circuit diagram of the laboratory radiophone

The arrangement of the apparatus can be made according to individual taste, but figure 1 indicates an arrangement which has proven very satisfactory. Whatever design or arrangement is determined upon, keep in mind that the shorter the leads, the better the results.

The various instruments are mounted on a ¼ inch bakelite panel and enclosed in a wooden cabinet. Dimensions of panel and cabinet are omitted as they will vary with personal taste.

Some source of high-potential direct current is necessary, preferably a motor-generator, but vacuum tube-rectified alternating current or storage batteries can be used. Two Western Electric VT2 bulbs should be used if possible, but Marconi Class II tubes may be substituted.

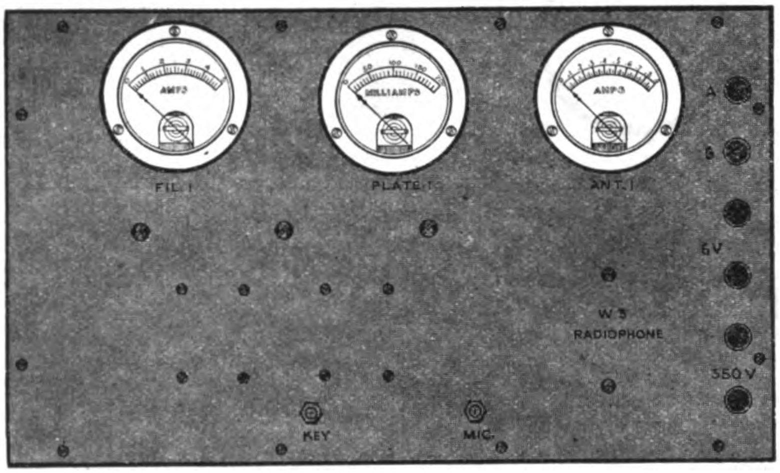


Figure 1—Front view of panel

An antenna condenser is shown in the wiring diagram, figure 3, but this is not necessary if the phone is to be used on one wavelength only. If several wave-lengths are desired, the condenser becomes a necessity. A balanced condenser of .001 mfd. capacity is a satisfactory instrument to use in this position.

The antenna inductance is wound on a bakelite tube, 3 inches in diameter, 5 inches long, with ¼ inch walls. Cardboard tubing, soaked in shellac and baked may be substituted if the bakelite tubing is not available. For the average amateur antenna, twenty-eight turns of heavy Litzendraht will be sufficient inductance, to keep the phone below 350 meters. The wire should be spaced 3-16 inch from the adjacent turn. If bakelite tubing is used, a thread can be cut on the outside diameter just deep enough to support the wire. A tap is soldered onto the fourteenth turn, and a lead brought out.

Three meters are used. A hot-wire meter of 0 - 1 amp. range for the antenna current, a milliammeter of 0 - 200 milliamperes for the plate current, and an ammeter 0 - 5 amperes for the filament current. Weston meters are suggested, but any meter with correct ranges and constants may be used.

Two closed core transformers are necessary—the transformer employed in the plate circuit, and the microphone transformer. A complete description of the construction of these coils is given in figure 2.

Two jacks are introduced, one for the microphone, and the other for a key to be used with the buzzer modulation. If undamped telegraphy is also desired, a condenser of .0005 mfd. capacity should be inserted between the grid and the antenna inductance, and shunted by a key. When the key is open, the tube is paralyzed by the negative charges on the grid and will stop oscillating. As soon as the key is depressed, the negative charge is dispelled, and the tube is at liberty to function again. If this condenser and key are used, it is well to keep in mind that while using the microphone or buzzer modulation, the condenser in the grid circuit should be shunted, either by a small switch, or by screwing the key down.

A battery of about 20 volts potential is placed in series with the secondary of the microphone transformer in order to keep the curve of the modulator bulb at a proper point to prevent modulator-blocking and resultant speech distortion. The polarity of this battery is important, and extreme care should be taken that the negative side is connected to the transformer and thence to the grid of the modulator tube. Any one of the numerous block B batteries of 22.5 volts potential on the market can be used.

The condenser used in the plate circuit, indicated on the wiring diagram as H, should be constructed of mica and copper foil, mounted between two strips of bakelite. The capacity is .01 mfd. This condenser is a standard size and can be obtained from any dealer of radio supplies.

The tube sockets should be fastened to a bakelite shelf and mounted in the rear of the panel. Two holes or a small door directly over the tubes should be cut in the cabinet. This will help to disperse the heat and also give the operator access to the bulbs in case a change is necessary.

A six-volt storage battery is used to light the filaments and supply the microphone current. Filament rheostats are unnecessary, but if their use is desired, it is advisable to use 8 or 10 volts instead of six.

All connections should be made of No. 16 bare copper wire covered with rubber or cambric tubing, and all joints should be securely soldered.

When the set is completed and ready for trial, shunt a condenser of about .001 mfd. across the antenna and ground leads. As the resistance of this condenser is low, this will serve to test the phone and will allow the operator to see whether his set is functioning properly before it is connected to the antenna.

When the bulbs are lit, the radiation meter should indicate about .8 amperes when the plate current is 100 milliamperes, and the filament meter indicates about 2.9 amperes. Plate current in excess of 100 milliamperes is apt to prove disastrous to the bulbs and consequently the current should not be allowed to go beyond that point.

Change the tubes back and forth until the best oscillator is determined upon. In nearly every instance where two tubes are used, one will be found to be the better oscillator.

If for some reason everything seems to be dead, check up wiring and polarities again. Another cause of failure to oscillate is due to not enough filament brilliancy. Sometimes .1 ampere difference in the filament current marks the dividing point between success and failure to oscillate.

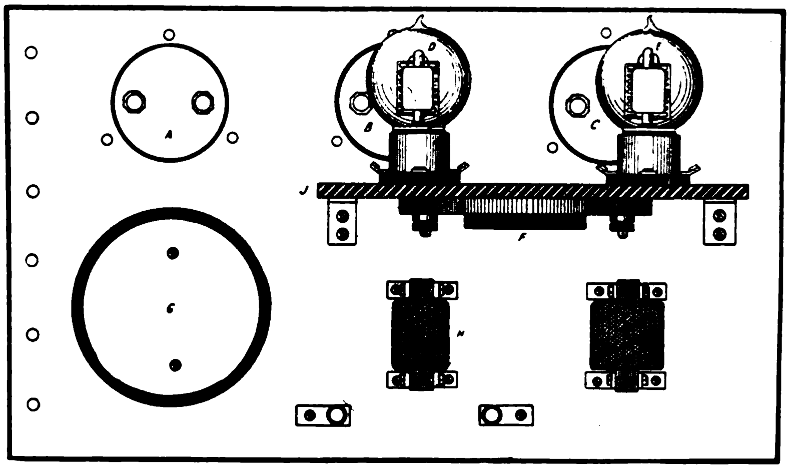


Figure 1—Rear view of panel showing location of instruments

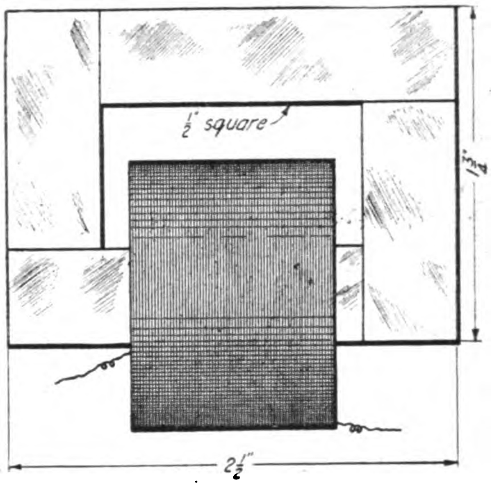


Figure 2—Dimensions and construction of coils

When the operator has satisfied himself that the phone is functioning correctly, the condenser is removed and antenna and ground substituted. The radiation drops to between .4 — .5 due to the increased resistance.

Good modulation is indicated by a slight falling off of the antenna current while speaking into the microphone.

When a buzzer is used, reduce the plate voltage and filament current, as the buzzer will cause a heavier plate current to be drawn than will the microphone.

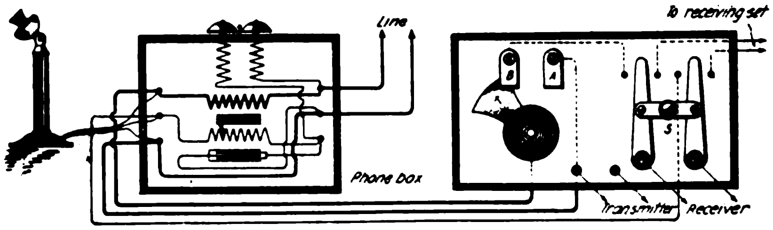
A radiophone similar to the one described above has been in use for six months and has given unfailing performance and satisfaction, and it is to be hoped that we will hear many more phones in operation when the radio season opens again next fall.

A Telephone Extension

By Eugene S. Pearl

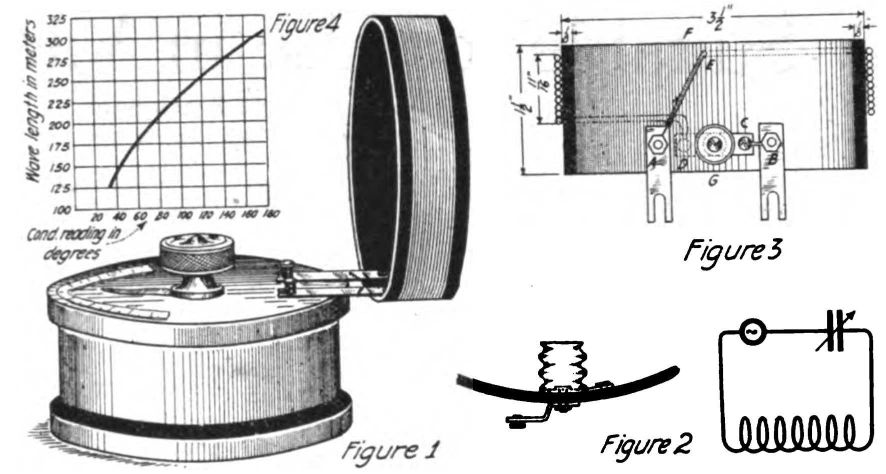
A GREAT many amateurs, whose radio rooms are located at a distance from the Bell telephone installed in their homes, would greatly appreciate an extension telephone at their wireless table, which would enable them to answer a phone call from their radio rooms, instead of having to leave while communicating with some amateur by radio. By referring to the diagram, an arrangement is shown which will accomplish this object. The upper part shows the regular phone box with its desk telephone; the lower part shows the addition to be made. The switch "S" is an ordinary pole changing switch that is used to connect the headphones with either the detector or telephone circuit. The switch C takes the place of the telephone hook switch, and being selective, it enables the wireless operator to obtain several combinations not possible with the regular telephone.

With switch-blade C in contact with B the headphones will be in circuit, causing no indication at central, thus permitting the operator to hear when the line is in use. With C in contact with A and B there is a regular telephone circuit. With C in contact with A alone the transmitter is in circuit alone.



An Efficient Wavemeter

By E. Singer



Constructional detail and graphic chart

THE instrument herein described is a wavemeter of simple construction, consisting of an inductance in series with a capacity and an indicating device as shown in the diagram.

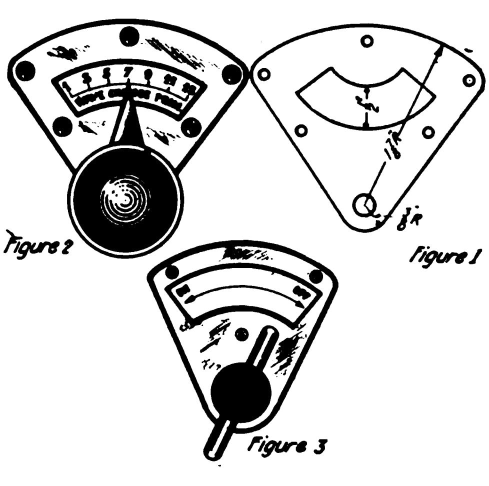
The capacity used is a Murdock 23-plate condenser. The inductance consists of 20 turns of No. 20 double silk covered wire wound on a piece of tubing whose outside diameter is 3½ inches. The length of the tubing is 1½ inches, with the winding starting at ⅛ inch from edge F. The end of the winding goes through a small hole at E and terminates on the brass strip A. The other end of the winding terminates on the outside of the tubing on the lug of the socket marked D. The dotted double line represents the two ends of the winding. The line running from E to A and from C to B are wires on the inside of the tubing.

The strips A and B are made of brass 1/16 inch thick, 1½ inches long and ½ inch wide. They are held to the tubing by 6/32 screws ¼ inch from edge G. The strips are connected to the tubing directly opposite the binding posts on the condenser, as shown in the photograph or sketch.

The indicating device consists of a receptacle for a miniature lamp with the porcelain portion removed and the socket proper mounted on the tubing as shown in figure 2. The center contact screw holds the socket to the tubing. The lamp used is a 2.5 volt Mazda lamp. The socket is mounted midway between the two strips. The wire CB connects lug C with strip B. The coil was given one coating of shellac after it had been wound.

Indicator Mounting

By D. R. Clemons



Dimensions and construction of the indicator mounting

IN the designing and construction of panel and cabinet types of radio instruments it is necessary that scales or other position indicators be used with the controls. Stamped lettering is not easily provided where the equipment is limited. Neither do scales or dials always apply to the position given them. When made to order they are too costly.

Recently a number of calibration and position indicators were desired. They were to be of uniform dimensions and design, yet having indicating lettering and directions each different from the other. By using uniform mountings and placing suitable indicators back of them, a very attractive arrangement was secured.

In the following figures the hard rubber plates were cut from discarded battery jars. After laying off the design on a piece of rubber, the opening was removed by drilling small holes within it, breaking out the piece and sandpapering the edges. Screw holes were drilled after the plate was grained by stroking it across coarse sand paper.

For each plate a piece of celluloid was cut to the same outside dimensions as the plate. With drawing instruments the scales and lettering was drawn within a space corresponding in size to the opening—heavy opaque drawing paper being used. The celluloid lies between the scale and the rubber plate all three being screwed to the panel front as shown in figures 2 and 3. The celluloid protects the lettering. It really is a small window. Such mountings function and appear well with the instrument. Three different patterns are shown in the drawings.

Second District Call Letters of Amateur Stations

(*Continued from July* WIRELESS AGE)

Letters.	Power.	Name and address.
2SA	21	J. P. Holder, 467½ Quincy St., Brooklyn.
2SC	50	Jos. J. Stantley, 1 Hampton Court Ter., Jersey City, N. J.
2SD	50	O. Dickinson, Albertson St., Hyde Park, N, Y.
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The Construction of a Portable Antenna Suitable for Use in Vacation Days

By F. C. Brockman

(FIRST PRIZE, $10.00)

THE antenna equipment described here is simple, easily erected and light enough to be carried by one person. It consists of two masts, each 21 feet high, a single wire antenna 75 feet long, a counterpoise of the same length, and four reels for the antenna, counterpoise, and guy ropes. The principal dimensions are given for those who wish to follow them. Minor dimensions are omitted as the amateur usually has a stock of odd parts which he can contrive to use.

Figure 1 shows the construction of a mast section. It is made of spruce, poplar, white pine, or some other available light wood of sufficient strength. Its length is 7 feet, which is convenient. Longer sections become cumbersome, while shorter sections require more joints, which often introduce weakness if improperly made. A 6″ piece of 1⅜″ O.D. by 1¼″ I.D. seamless steel or brass tubing is shown at b. It is pinned to the mast by an iron or brass pin of ⅛ to ¼″ diameter as at e. Provide three 5/16″ holes, d, spaced 120 degrees apart and with their centers ⅜″ from the open end of the tube. These holes receive the hooks on the ends of the antenna and guy ropes. A 3″ piece of standard size tubing 1¼″ O.D. by 1⅛″ I.D. shown at a, can readily be purchased. Take a light cut off the smaller tube to make it fit into the larger one snugly. This had better be done in a lathe if one be available, otherwise it can be worked down with emery cloth. Force the tube onto the end of the section, drill diametrically and countersink for a pin, c, made of iron or brass wire about ⅛ to ¼″ in diameter. Rivet the ends of the pin and file flush with the tube. Paint the section an olive drab color, leaving the inside of the large tube and the outside of the small tube clear. If they are of steel give them a thin coat of oil occasionally to prevent rust.

Make six such sections and you will have two masts each 21′ high. They are all alike and therefore interchangeable, which facilitates erection. The sections are carried in one bundle. Procure a double book strap or bundle carrier having a suitcase handle and straps fitted with spring buckles. Use this in the middle of the bundle and one single book strap with spring buckle near each end. By using additional straps the four reels and the stakes may be attached to the masts and the whole outfit carried by one person.

Figure 2 shows the construction of the antenna and insulators. A harness hook or snap hook which will fit into the holes d in the tube b of figure 1 is shown at a. Six of these hooks are required, two for the antenna and four for the guys. An insulator, b, is made preferably of XX black dilecto, 3/16 by ⅜″, although hard rubber will do as the strain is not very great. Links, c, are made of No. 9 iron wire bent into U-shapes with the curved part of sufficient diameter to work easily in the eye of the hook a, and with the ends flattened. Four of these links are needed. Clamp one end of an insulator between the ends of a link, with a hook in place, drill two holes and rivet together with iron, brass, or copper wire about 1/16 to ⅛″ diameter as at d. Do likewise with one end of the other insulator. Rivet the other two links to the remaining ends of the insulators.

For the aerial wire secure 75′ of No. 18 lamp cord, although bare stranded wire of the same size will be considerably lighter. Loop the ends through the links on the insulators as at e, figure 2; twist them back on the main wire and solder, using a rosin and alcohol flux, as acid fluxes will soon eat through the strands and cause a break. Secure a 25′ piece of the same flexible wire, loop one end through one insulator link as at f, figure 2, twist back on the lead and also around the aerial wire and solder. Good soldering is essential as the energy handled is small and none must be lost in bad joints. Solder a spade terminal such as is used on automobile ignition cables to the free end of the lead for connection to the instruments. The aerial wire is now complete with its insulators, down-lead, and hooks for securing to the masts.

The counterpoise is shown in figure 4. It consists of 75′ of automobile ignition cable or some other flexible stranded cable with heavy rubber insulation. Solder a spade terminal to one end and double the other end back for about one foot and tape securely so as to insulate it.

Figure 5 shows a guy rope. It is made of 30′ of 3/16″ braided shade cord. One end is tied to a harness hook, a, the other is looped through a 3″ tent slide, c, by means of which the guy may be made taut. If tent slides cannot be obtained, a piece of hard wood 3″ long, ½″ by 1″ in sec-

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tion, and fitted with two ¼" holes 2" apart may be used, or an ordinary cord tightener as used on a drop light will do very nicely. Four of these guy ropes are needed.

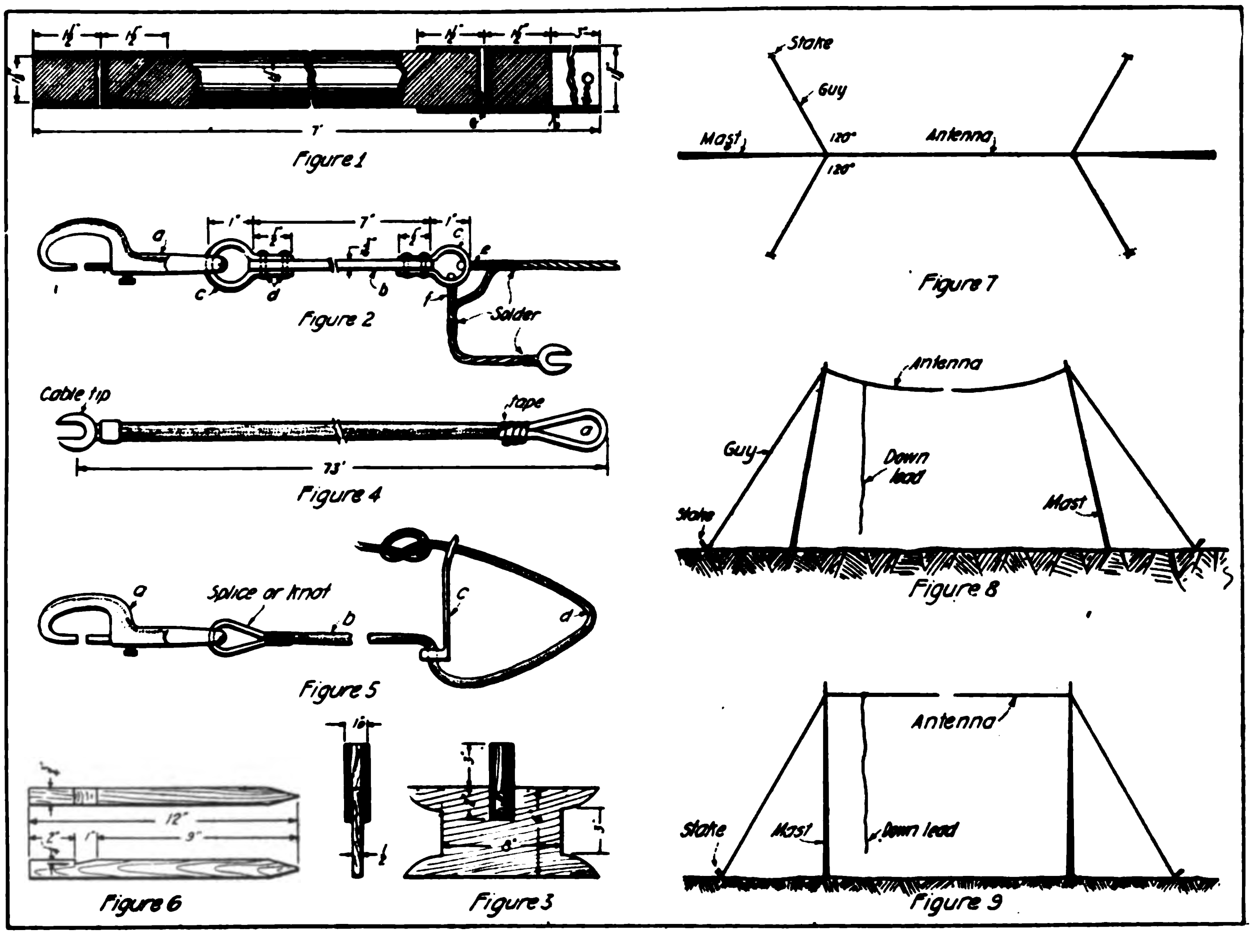
Figure 6 shows the stakes to which the guy ropes are fastened. They should be of hard wood. The loop of the rope is hooked under the notch to prevent its slipping off the end of the stake.

Figure 3 shows the reel. One carries the antenna, another the counterpoise, a third carries one pair of guy ropes, and the fourth carries the other pair of guys. The reels are made of ½" hard wood as shown in the figure.

One person can very easily erect this antenna, although two or more can, of course, do it more quickly. First choose a suitable place, reel out the antenna so that the free end points away from the station with which communication is to be carried on, and find two points about ten to fifteen feet from the ends of the antenna, and on lines which make approximately 120 degree angles with it and drive stakes leaning away from the antenna. Then lay three mast sections at each end of the antenna with their bases pointing away from it. Join them together, hook the antenna and two guys into the holes in the topmost sections and loop the other ends of the guys over the stakes. Grasp the mast a little below the middle and raise it till it stands at an angle, leaning towards the antenna. Repeat this with the other mast. Then take up on the guy ropes and adjust the position of the masts till they are vertical.

Figure 7 shows diagrammatically the parts laid on the ground. Figure 8 shows the masts leaning against the guy ropes. Figure 9 shows the antenna erected.

Set up the apparatus near the down-lead, reel out the counterpoise, laying it under the antenna. Loop the far end under the mast to keep it stretched out and running parallel to the antenna.



Views showing construction and method of erecting the portable antenna

The Construction of a Portable Antenna

By A. Hazleton Rice, Jr.

(SECOND PRIZE, $5.00)

THE camper of today takes the marks of civilization with him wherever he may go. He wants to keep in touch with the world no matter how far from its centers of civilization he may roam, and he turns to science for the gratification of this whim.

Through the development of radio telegraphy and telephony during the war, the seemingly impossible has not only been accomplished, but has become routine in operation, making it entirely feasible for the camper to include in his list of necessities a well designed radio outfit.

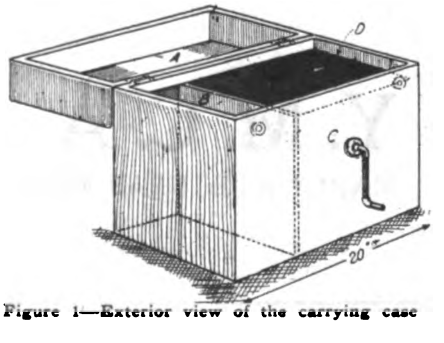


Figure 1—Exterior view of the carrying case

A radio station, to be of any value on a camping trip must be light in weight, efficient in operation, and easily moved from place to place. All of these characteristics are largely dependent upon the antenna, which must be portable, if it is to meet the requirements of the most exacting amateur. The antenna which will now be described is easily carried about, can be raised or reeled in without much difficulty, and incidentally may be so designed as to include the receiving set as well.

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Supports are dispensed with, for at best they are cumbersome affairs on a canoe trip or when it becomes necessary to pack everything on one's back.

The most desirable method of suspending a portable antenna, then, is from a natural support, such as the limb of a tree, the roof of a house, or, as will probably be the case, between two trees the right distance apart.

The dimensions given, therefore, are suggestive only, as the requirements of the individual will vary greatly.

The carrying case should be built of ½" oak or birch, as shown in figure 1. The cover should be hinged at the back and two hooks and screw eyes are used to keep it securely closed when it is being carried about. The case, when completed, should be stained some dark color; fumed oak is perhaps the best in appearance and durability.

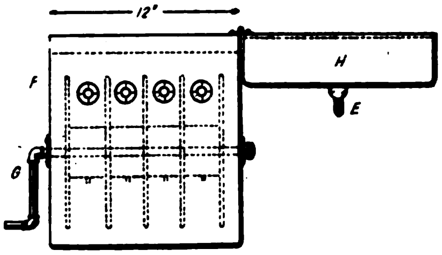

Figure 2—Interior diagram of carrying case showing drums

A comfortable leather handle should be fastened securely to the cover.

Several wooden drums 3½" in diameter by 2" long and a number of flanges of ½" stock and of proper diameter should then be turned out on the lathe. The number will depend entirely upon the number of wires to be used in the aerial and the diameter of the flanges. Litz wire is the most flexible and will reduce the size of the carrying case materially; the so-called "Belden" cable and lamp cord, although flexible, are much more bulky. When the wire to be used has been decided upon, 100 feet should be purchased and reeled up roughly on a spool having a diameter of about 3½" and 2" in length. In this way an estimate of the size of the flanges required may be made.

By actual experiment, two wires have been found to be as efficient as four for receiving, and the reader is advised not to carry more than this number for his antenna, each of which should be 100 feet in length. This length will give the antenna a fundamental wave length suitable for 200 to 800 meter work.

In addition to these, a 60-foot length of wire is required as the lead-in. This length should prove ample for all practical requirements.

If a two-wire aerial is decided upon, three drums will be required for the wire alone, together with the necessary flanges to keep each in its proper place.

In addition to this a fourth drum, of the same size, is necessary upon which to wind the hoisting "rope" which, in order to persist in our policy of flexibility, may consist of a heavy linen "fish" line such as is used for big game fish. A 100-yard length is necessary and it should be cut into two 150-foot lengths and reeled onto the drum at the same time. These lengths will allow a maximum height for the antenna of 75 feet, which is more than ample; the average being about 40 feet.

After the flanges and drums have

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been turned out they should be carefully drilled through their centers to fit a ½" brass pipe which is to be used as the arbor. The arbor should be sufficiently long to extend through the front and back of the carrying case and a sufficient number of threads should be turned on each end to enable the drums to be tightened so as to prevent rotation by the use of large nuts and washers. A pipe cap should be screwed on the arbor at the rear and two brass elbows and short lengths of pipe may be screwed on at the front as shown to form a very rugged handle. Brass pipe flanges of suitable size may be used as the bearings and should be screwed securely to the outside of the carrying case.

Similar flanges may also be used as guides for the wire and ropes when reeling and unreeling, but they should be carefully smoothed up on the inside with a round file and emery paper. They may then be screwed to the end of the case; the center of each being about opposite the center of its respective drum and on a level with the maximum height of the coils.

Each end of each antenna wire should be provided with a "snap" hook which makes it an easy matter to fasten them to screw eyes in the spreaders. These hooks should be tied to the wire by use of the familiar bowline knot. Screw eyes should also be fastened to each drum on the reel so that when being reeled up the wires may be merely inserted through the "portholes" from the outside and snapped onto the drums.

The lead-in wire should have a tap securely spliced and soldered at about 3 feet from the end, and securely soldered on each branch is a clamp like those used on transmitting helices.

Each spreader, when extended, allows for a span of 3 feet between wires, and should be of sufficient diameter to withstand the strain. One inch square, straight grained material is suggested. Each half of each spreader is 18½" long, and the two halves should be hinged. When extended, two pieces of strap iron may be bolted opposite the hinges to maintain rigidity. In folding the spreaders, however, it should only be necessary to remove one bolt. A screw eye should be fastened to each end of the spreaders, both front and back.

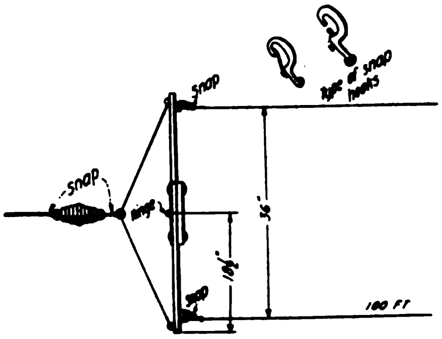
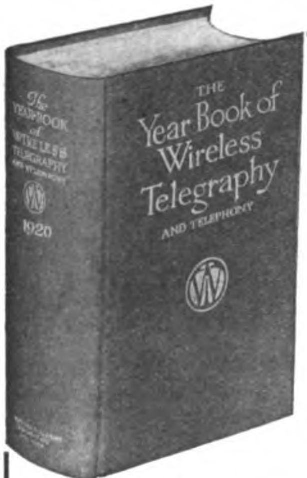


Figure 3—Antenna construction and rigging

With the addition of short lengths of line fastened at each end of the spreaders and two electrose ball insulators the antenna is now complete and ready for erection.

This is easily accomplished. A desirable spot is chosen; preferably a place having but a few trees with branches well above the ground. Ropes and wires are then unreeled and unfastened. Each rope is fas-



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tened to an insulator which, when used as a weight, can be slung a considerable height. There is usually a good tree climber in the party, in which case the problem is much more easily solved. After the ropes have been thrown over their respective supports the spreaders are fastened to the insulators; the antenna wires bared at one end; the lead-in wires clamped on; the antenna wires snapped into the screw eyes on the spreaders and we hoist away. Reference to the drawings will undoubtedly make it all clear.

A word on "grounds" may not be amiss, for portable aerials and portable grounds usually go hand in hand, and the one is as essential as the other.

Don't drive a short iron pipe into the ground and expect results. You won't get them.

If the experimenter is on a canoe trip, his one best bet for a ground will be in the water; a roll of chicken wire has been known to give excellent results when placed under water. Two additional lengths of wire may also be laid upon the ground directly underneath the antenna wires, thus acting as a counterpoise, and will give good results. By the addition of two more drums to the reel, these wires may be carried without inconvenience.

As shown in the drawing, the receiving set may be conveniently mounted on bakelite or hard rubber and fastened to the inside of the cover of the carrying case.

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Portable Mast

By C. R. Leutz

(THIRD PRIZE, $3.00)

THE following described portable mast was designed for Boy Scout use and was very successful in practice, although it required four men to erect it. However, a mast fifty-five feet high could not be expected to be raised quickly without four men.

It was decided that one large mast would be a better proposition than two small masts both from the point of bulk and from the standpoint of operation in service and the weight to erect. The type thought of was a built up hollow mast. A model mast was constructed and found very satisfactory and a large type was then planned in accordance with the model.

The height decided upon was fifty-five feet. An umbrella antenna at this height was suitable for 200-meter transmission and reception and also suitable to string a large antenna to some high surrounding point for long distance long wave reception. Out of the fifty-five feet, this mast was divided into five sections, four ten-foot and one fifteen foot.

In the selection of the wood a strong light wood is most desirable, say clear spruce, poplar, basswood or whitewood. Figure 1 shows the cross section of one mast section, the lower fifteen-foot piece. This is built up of six pieces of wood that have previously been cut and planed in accordance with a template laid out on paper. The most successful manner to build these strips would be on a

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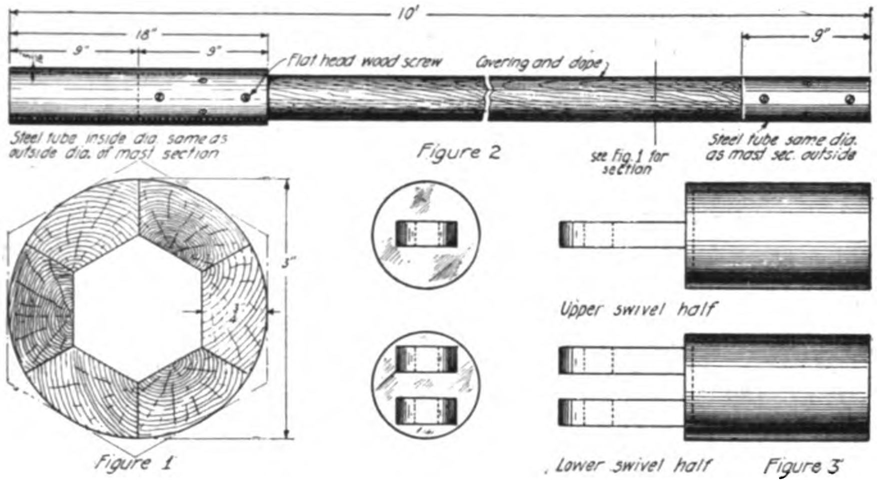
buss-planer if available, otherwise careful hand planing will have to be done.

Four or five octagonal shaped pieces the size of the inside diameter of the mast are cut to allow the six pieces to be assembled without falling apart. Gluing is done immediately with the best grade of flake fish glue. This glue is bought in sheets and should be cracked up and boiled in water to a consistency where it drops slowly on the end of a stick after dipping. After setting twenty-four hours the portion shown in dotted lines should be turned off in a lathe or planed off by hand, to approximate a circle. The pole may then be varnished or, first, preferably, covered with a layer of airplane linen and varnished at the same time. Valspar varnish will be found entirely satisfactory.



Construction and dimensions of the hollow wooden mast

Figure 2 shows the middle section (one of four) fully assembled. Notice that on one end, the wood has been turned down 3/16" and 9" back and a piece of steel tube driven on and held with countersunk wood screws. At the other end, a larger piece of steel tube is slipped over the outside of the mast section and held there with wood screws. Nine inches protrude beyond the end of the section to receive the opposite end of the following section. Considerable trouble in making each section somewhat smaller than the next higher section will be experienced, but it is worth while if one has the time.

Tube fittings are not made for the joint between the last ten-foot length and the first fifteen-foot section, as a swivel joint is placed there in accordance with the sketch, figure 3. This consists of two iron castings to fit over the end of the first fifteen-foot section and the joining ten-foot section. The purpose of this section is obvious when studying the sketches.

Now, having the mast sections, tube fittings and swivel joint all complete,

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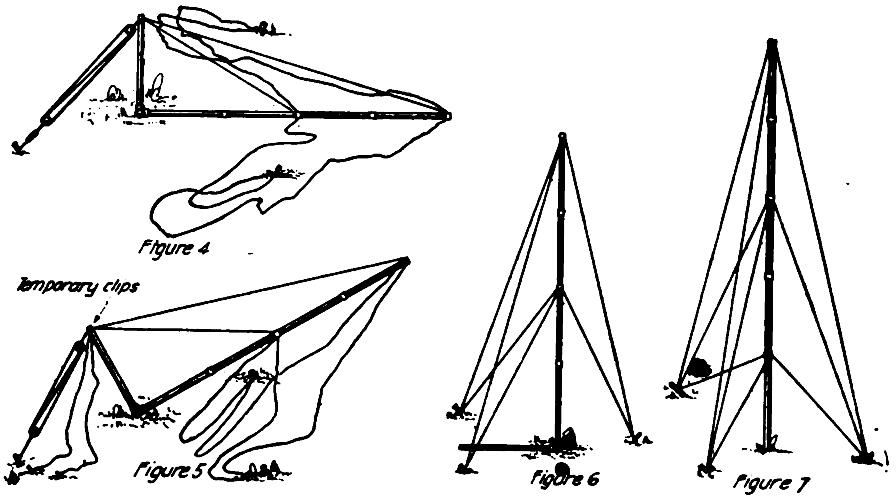
there remains the guy wires and other accessories to lay out. At the top of the mast, twenty feet down and just above the swivel, an iron band should be placed around the mast and fastened to prevent slipping. Holes should be provided to fasten guy wires, which are, of course, the antenna wires as well. The guy wire lengths can be calculated and cut exactly to the required size. They should not reach to the ground, as there is an insulator and piece of rope at the end of each guy, as shown in the sketch. Four iron stakes with loose rings should be made, three for guys and one for the erection operation.

The four ten-foot sections are first placed in each other at the joints and laid out along a smooth stretch of land. The top and middle guy on one corner of the triangle is fastened at the temporary clips that hold the fifteen-foot section at right angles to the four ten-foot sections. A pulley is fastened on the top of the fifteen-foot section and this is used as a gin pole. The other sets of guys (two) are run out along the side of the pole to the stakes, their position being measured. The rope running to the pulley is then taken to another iron stake and the mast is ready for the first hoisting operation.

One man holds the left side guys and one man holds the right side guys while two men pull on the pulley running to the gin pole. The mast may buckle slightly but can be raised without difficulty. After the gin pole is pulled to within twenty degrees or so of the ground, the pole can be pushed to the ground. While one man is at one of the three sets of guys feeding out as required, a fourth man, or two, if available, should lift the fifteen-foot section up from the ground to a vertical position. There are three guys at the swivel joint, and once the mast is raised above the forty-five degree position considerable assistance can be given by pulling on the guys.



Method of erecting the antenna mast

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The subject for the new prize contest of our year-round series is:

"CRYSTAL DETECTOR SETS FOR USE WITH INDOOR AND OUTDOOR ANTENNAE"

Closing date, October 1, 1920.

Contestants are requested to submit articles at the earliest practicable date.

Prize Winning Articles Will Appear in the December Issue.

During the winter months thousands of new amateurs will be setting up small sets and listening-in while many who have been among us for years will once more bring their old reliable crystal detector into use. We should like to hear something new in crystal detector design and hook-up. Here is an opportunity for you to help out the newcomer as well as the oldtimer.

PRIZE CONTEST CONDITIONS—Manuscripts on the subject announced above are judged by the Editors of The Wireless Age from the viewpoint of the ingeniousness of the idea presented, its practicability and general utility, originality, and clearness in the description. Literary ability is not needed, but neatness in manuscript and drawing is taken into account. Finished drawings are not required, sketches will do. The contest is open to everybody. The closing date is given in the above announcement. The Wireless Age will award the following prizes: First Prize, $10.00; Second Prize, $5.00; Third Prize, $3.00, *in addition to the regular space rates paid for technical articles.*

All manuscripts should be addressed to the Contest Editor of The Wireless Age

---

The guys are all the right length, and fastened to the insulators. The slack taken up by the ropes running from the other side of the insulator to the iron stakes make the mast vertical. This may seem like a difficult proposition, but if the mast is constructed properly, the total weight is only about forty pounds from the swivel joint up and can easily be lifted as described and in a surprisingly short time.

During experiments, four men raised a mast of this type completely in twelve minutes, and started to receive signals and then dismantled the mast and was under way in seven minutes.

Three upper sections were strapped together for one man, and one ten-foot mast and the lower mast strapped together for the second man. The third man carried the iron stakes, pulleys and rope and storage battery and the last man carried the apparatus. Surprising results were had when the mast was erected on top of high hills clear of surrounding countries.

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Chicago Amateurs' Annual Report

CHICAGO now has 262 amateur radio stations, according to the annual report made to Washington by Charles C. Kolster, United States radio inspector for the Chicago district, and for the first time in the history of the local radio station the number of commercial radio operators seeking jobs exceeds the vacancies.

Until a month ago commercial operators were in demand, the vacancies outnumbering the applicants by fifteen. However, during the past month, twenty-eight applicants successfully passed the government examination, a number of whom have since been placed in positions.

Since October 1, 1919, when the government ban on amateur radio stations effective during the war was raised, 872 stations have been opened in the Chicago district, which takes in Illinois and eleven neighboring states.

While Chicago, St. Louis and Kansas City, all in this district, are well represented among the amateurs, the smaller cities and rural districts have their share of radio fans. Boys from all parts of the state and even from neighboring states come into Chicago to take the examination, not waiting for the time when examinations will be given near their homes.

There is no enthusiast like the radio fan. Their cheapest equipment costs about $250, and in some cases their plants represent an investment of several thousand dollars. Right now there would be double the number of amateurs in the district if the apparatus were obtainable. Manufacturers report that they are as far as eight months behind in filling orders.

In order to pass the examination as amateurs, applicants must have a thorough knowledge of their equipment, know the regulations pertaining to national and international radio traffic, and be able to receive at least twenty words a minute in the code test.

Out of 533 taking the examination as commercial operators, since Oct. 1, 1919, only 228 were successful. The majority of the amateur stations can transmit messages only a few hundred miles. However, several in the district are known to have sent messages as far as Washington and intercepted messages at greater distances.

Honeycomb Inductance Coil Mounting

By Clyde J. Fitch

IN a recent issue of THE WIRELESS AGE I described the construction and mounting of honeycomb inductance coils. Since then I contrived the mounting shown in the accompanying drawing, which is so simple and easy to construct, that it should be preferred by experimenters. I have used this mounting and it works satisfactorily.

After the coil is wound and removed from the arbor, the holes for the brass machine screws are made by forcing round pointed wooden pegs, slightly larger than the machine screws, through the winding. The winding is then given a thick coat of orange shellac and baked till it is thoroughly dry. It will be thoroughly dry when all the odor has disappeared. The wooden pegs can now be removed and the machine screws inserted, using a fiber washer on each side of the winding. The two ends of the winding are each connected to a machine screw. The coil can now be inserted in the clips as shown in the drawing, the head of the machine screws snapping into the holes in the clips. This allows the coil to swing sideways, which will vary the coupling between two or more coils mounted side by side.

The hard rubber knob may or may

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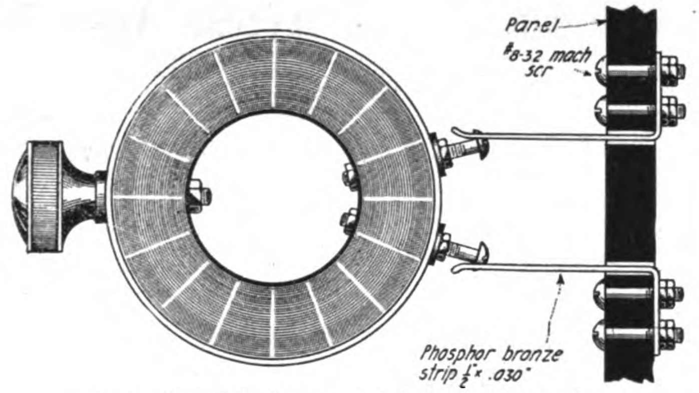
not be used depending upon the fancy of the builder. It will help to overcome the capacity effect due to the nearness of the operator's hand when the regenerative circuit is used, which is not exactly a disadvantage, as tuning is accomplished with the variable condensers alone.



Construction of the honeycomb inductance coil mounting

Queries Answered

Answers will be given in this department to questions of subscribers, covering the full range of wireless subjects, but only those which relate to the technical phases of the art and which are of general interest to readers will be published here. The subscriber's name and address must be given in all letters and only one side of the paper written on; where diagrams are necessary they must be on a separate sheet and drawn with India ink. Not more than five questions of one reader can be answered in the same issue. To receive attention these rules must be rigidly observed. Positively no Questions Answered by Mail.

G. H. C., Wisconsin:

The only improvement we can suggest is to get a vacuum tube and use standard diagrams with regenerative connection. Your apparatus appears to be O. K. but it is not sensitive enough to receive long distance stations, or weak signals which amounts to the same thing.

* * *

C. M. G., Missouri:

1. In order to give you the exact size of the condenser for a one half kilowatt set it is necessary to know the frequency of the supply line, the secondary voltage of the transformer and the number of studs and speed of the rotary gap.

2. QSA means: Are my signals strong? Your signals are strong. QRM means: Are you being interfered with? I am being interfered with.

3. If you have a license for the station and one for yourself your brother can transmit under your supervision.

* * *

C. K., Ohio:

The size of the Audio-choke coil you speak of depends upon the impedance of the tube it is used with and too many factors must be known in order to properly design one. Would suggest that you use a secondary unit from a one or two-inch spark coil with an iron core, made of a bundle of iron wires, in the center. Simply try various coils until loudest signals are heard.

* * *

W. T., Tennessee:

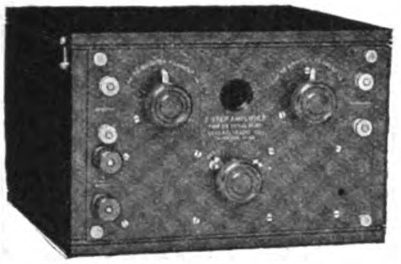
1. The best answer we could give you would only be theoretical and until we find out what electricity is, it is almost useless to explain, in the true sense of the word, just how the current does flow from the plate to the filament.

2. The multi-layer winding gives greater inductance in a smaller space and less capacity for the same amount of wire than the single layer coil type.

3. The connecting of rectifiers in series is something that would have to be tested. While the idea is not new we can not say at the present writing just what the action would be. Why not try it and if successful write an article regarding your results?

4. Fahnestock Binding Posts may be ordered from the Fahnestock Electric Company, Meadow, N. Y. Hunterpoint 877.

5. In regards to bare tinned copper wire, would suggest that you get in touch with wire manufacturers listed in the advertising section of the "Wireless Age."



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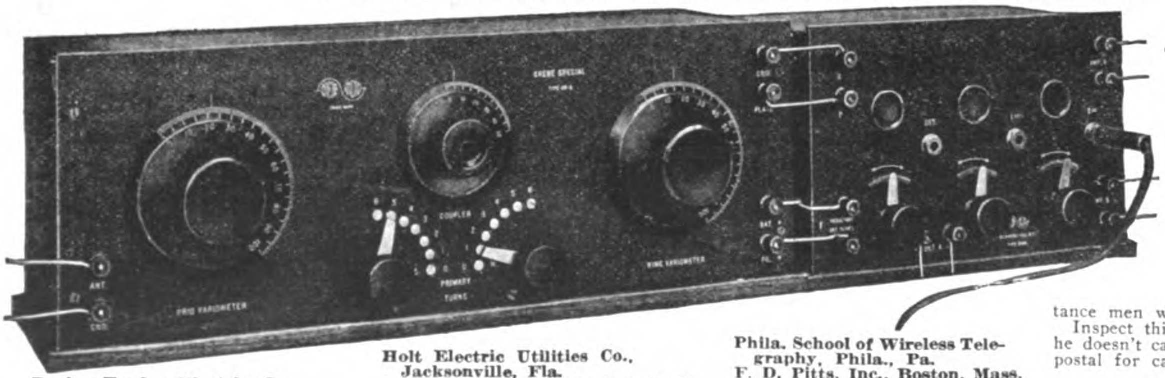

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Operating Suggestions for the Radio Amateur

By Leigh M. Townley

I'M an amateur myself and this idea of eliminating jamming hits me just right. Previous to the war we had a system in our town which gave real operators a chance to work, new "birds" a chance to listen-in on the good stuff and lots of chance for them to CQ around and test. It is my belief that if this system were improved upon and enlarged to take in more than one town, it might be worked with success for the benefit of all amateurs and the improvement of working conditions in the air.

From 1915 to and through 1917 we had an epidemic of radio bugs. The big idea of everyone seemed to be that if your set was powerful enough to jam through the others you could work, otherwise you were out of luck. It was this condition of affairs that gave rise to our scheme.

All the amateurs, or at least as many as could, got together to discuss this problem. We had no radio club and no one seemed to be anxious to start one because of the great range of ages, nationality, religion, station in the social life of the town, yes and even the difference of sex of the amateurs. However after several meetings we devised this system.

Because there were so many of us in such a small space, promiscuous "flat chewing" must be done away with. Testing was limited to the last ten minutes in each half hour and the station's call must be signed. If important work was being carried on, testing must be postponed till the next test period. Four fellows, owners of 1 k.w. sets. were appointed to act in a sort of advisory capacity as control stations. They were numbered 1, 2, 3, 4 and took their seniority in order of their number so that if more than one happened to be on at once, it would be understood who was on command

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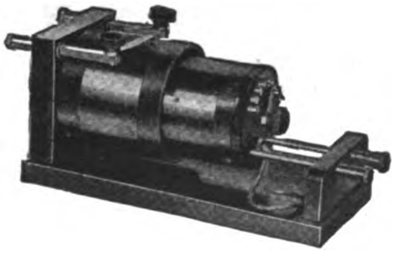

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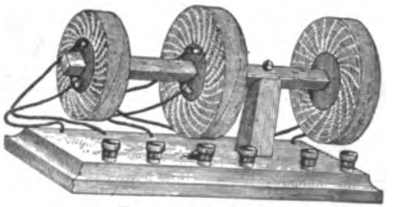

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of the air. They had absolute QRT privileges over the stations in that vicinity and could pipe anyone down at will and could also give anyone "clear air" at will. Believe me, when one of these amateurs heard a QRT fired at him from one of those stations he never let a peep out again until told that he could by proper authority.

In this manner, if anyone has business to clear he would call the control station on at the time and request clear air. The control station would clear the air by a CQ—QRT and then tell him to go ahead. If, in the estimation of the controlling four stations, one station was requesting clear air more than was his right he was told to lay off for a while. This eliminated useless calling because the controlling stations kept a log of all the stations on at the time and should anyone start calling a station which was not on, the control would tell him so and tell him to QRT 'til that station reported on.

We found this system worked O. K. chiefly, because, if there were any offenders they were immediately discovered and a mad gang of radio operators is not pleasant to settle with. Then again it made the beginners come on when no business was being handled and no one cared if they CQ'd their set apart. This little idea seemed to improve the operating, because everyone wanted to handle real business, but no one wanted to ask for clear air and then fall all over themselves with the whole gang listening in.

While this scheme worked beautifully in a small city and the surrounding country it might not prove so successful on a large scale but it is my conviction that if all the radio clubs and associations of the country were to adopt this scheme, jamming and all its attendant evils would be materially reduced. At any rate a beginning has to be made and practical experience with the scheme here outlined will no doubt establish its value.

Book Reviews

The Year Book of Wireless Telegraphy and Telephony, 1920. Cloth binding, 1148 pages. Illustrated. Wireless Press. Price, $3.75, postpaid.

The eighth successive year of publication is marked by the issuance of the current edition of this standard reference work. The volume appears considerably enlarged in scope and with many novel features.

The section devoted to the Record of Development chronicles the many epochal events in radio during 1919 and completes the record from the year 1827 to the beginning of the present year. The very comprehensive section containing the National and International Wireless Laws and Regulations stands unrivalled and unique in its complete form, incorporating the full text of the International Radio-telegraphic Convention and the Safety of Life at Sea Convention, as well as the laws and regulations of all the countries of the world. In this section alone are 400 pages of information obtainable in no other single volume. Noteworthy among the additions to this section are small maps which show the position of the wireless stations in each country.

The Directory of the World's Wireless Stations occupies 386 pages and lists land stations and ship stations, giving call letters, range, wave-lengths, nature and hours of service, owner and message tariffs. The key list to the call prefixes of all nations are also included, together with valuable data on meteorology. Time and weather signals are dealt with internationally, complete information on all countries and a full interpretation of the symbols being included.

A new feature, and a specially valuable one, is a series of special articles reviewing the development of radio in the principal countries during the past year. Each resumé is written by an authority in the countries represented, which include France, Germany, Great Britain, Holland, Italy, Japan, Norway and the United States. The thought of eminent scientists is also expressed in general articles devoted to: The Progress of Wireless Telephony; Valve Amplifiers for Shipboard Use; Wireless Telephony and Its Application to Aircraft; Direction Finding; The Berne Bureau; and Radiotelephony and Aviation.

A patent section records the issues of the past year and segregates those relating to vacuum tubes. The useful data section has been exhaustively revised, giving tables and general information along with the terminology of radio and foreign equivalents.

Complete information about all the principal commercial radio companies is again included, along with biographical notes of the world's leading authorities on wireless. The literature of the art is catalogued in another section, inclusive of books and periodicals and the most important articles which appeared last year, according to the subject discussed. An amateur section and a code signal section concludes the volume.

Obtainable through the Book Department, The Wireless Age.

Radio Engineering Principles. By Henri Lauer and Harry L. Brown. Cloth binding, 295 pages. Illustrated. McGraw-Hill. Price, $3.50 net.

The purpose of this book is to record and explain the extensive developments in radio made during the war. It is devoted principally to study of the characteristics and use of the vacuum tube, but deals with the essentials of the older apparatus in which important principles are embodied. The use of mathematics is kept to the minimum and appears only when essential to clarify the theory. The volume, in fact, concerns itself only with instructing the reader in radio communication principles and the general means of utilizing these in practical work.

Obtainable through the Book Department, The Wireless Age.

Practical Amateur Wireless Stations. Compiled by the Editor of The Wireless Age. Paper, 136 pages. Illustrated. Wireless Press. Price 75 cents net.

This volume is announced as an experience book, containing the best suggestions of thirty-three experimenters on building, installing and operating experimental stations for radio communication. In a foreword its purpose is explained as that of presenting in convenient form the experience of practical workers in the art. The methods described as those which the authors have worked out and tried out themselves, and the same is true whether the chapter deals with a single piece of apparatus or a complete station. The selected chapters made their first appearance in The Wireless Age in the form of magazine articles, giving the volume the peculiar merit of standing as a record of results and final conclusions, presented without the restriction of viewpoint by prejudice or preference that obtains in the writings of a single author.

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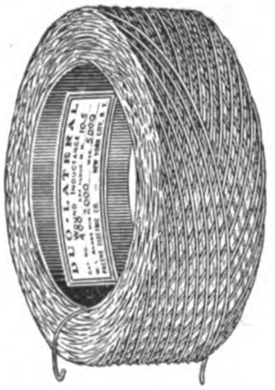

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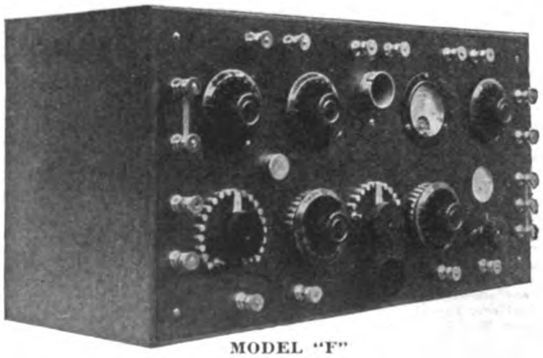

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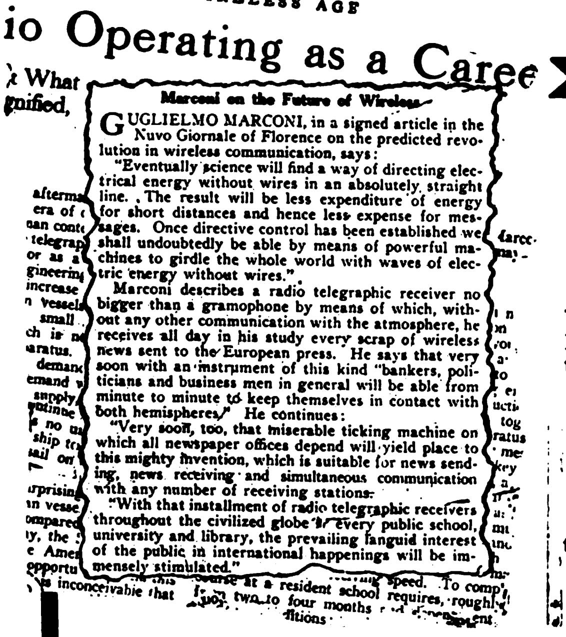

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What gnified,

Marconi on the Future of Wireless

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Marconi describes a radio telegraphic receiver no bigger than a gramophone by means of which, without any other communication with the atmosphere, he receives all day in his study every scrap of wireless news sent to the European press. He says that very soon with an instrument of this kind "bankers, politicians and business men in general will be able from minute to minute to keep themselves in contact with both hemispheres." He continues:

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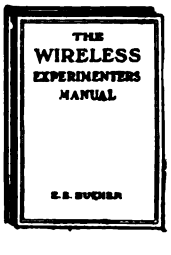

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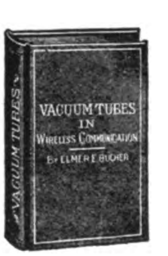

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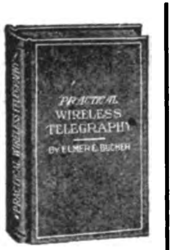

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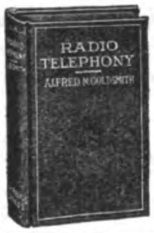

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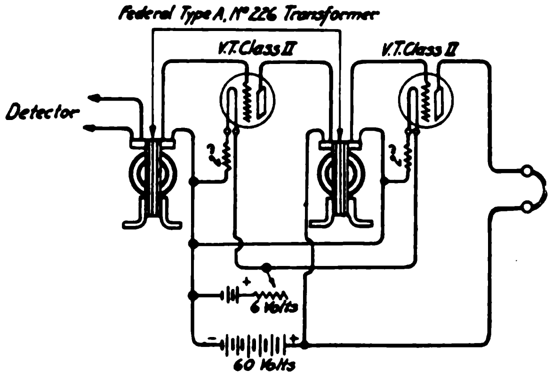

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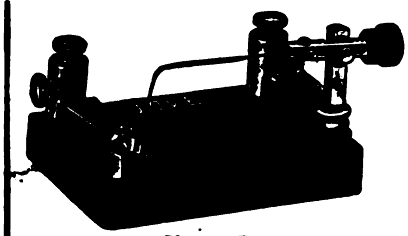

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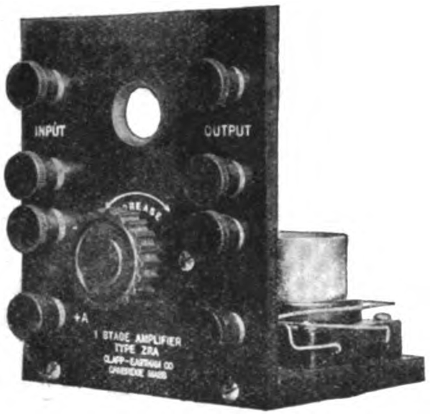

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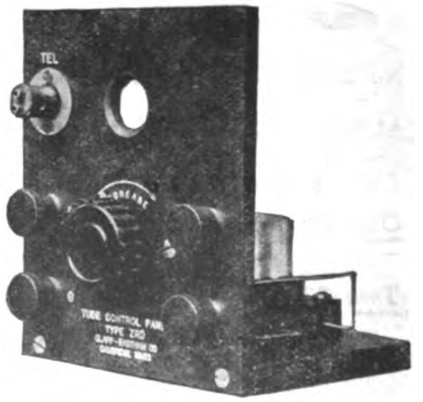

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